ASSESSING LOCAL PRESCRIPTION CONDITION FREQUENCIES

Program RXWTHR and Program RXBURN

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FINAL REPORT

submitted by

Larry S. Bradshaw

to

Fire in Multiple Use Management RD&A Program
Northern Forest Fire Laboratory
Missoula, Montana

in fulfillment of

Supplement Number 1
Master Memoradum of Understanding
dated 2 August 1977

December 1978

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FINAL REPORT

submitted by

Larry S. Bradshaw, Meteorologist   Date

accepted by

Collin D. Bevins, Principal Investigator   Date

approved by

Dr. James E. Lotan, Program Manager   Date

William C. Fischer, Research Forester   Date

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PREFACE

"Assessing Local Prescription Condition Frequencies" is submitted in fulfillment of sections 6.1 through 6.3 of the study plan of Supplement Number 1 (amended) to the Master Memorandum of Understanding effective 2 August 1977, between Systems for Environmental Management, Missoula, Montana, and the Intermountain Forest and Range Experiment Station, Ogden, Utah. The study was performed under cooperative aid agreement between Systems for Environmental Management and the Fire in Multiple Use Management RD&A Program, Northern Forest Fire Laboratory, Missoula, Montana, under authority 16 USC 581, 581a - 581i. Systems for Environmental Management is an Montana non-profit research and educational corporation cooperating with land management agencies in the interest of improved environmental management.

FOREWARD

"Assessing Local Prescription Condition Frequencies" is structured in three sections. In total the three sections constitute a final report to a cooperative aid agreement between the Fire in Multiple Use Management RD&A Program, Intermountain Forest and Range Experiment Station, USDA Forest Service, and Systems for Environmental Management. The first section contains a brief discussion on the purpose of the project, project objectives, system design, system options and output, and user interface. Section 2 is the Users' Guide, and Section 3 contains documentation of the two software packages produced in the course of the project.

ACKNOWLEDGEMENTS

Several persons who have expended energy to this project in the form of time and thought deserve special thanks. Dr. James E. Lotan and William C. Fischer, both of the Fire in Multiple Use Management RD&A Program, were influential in developing and financing the project. Roger McClusky, formerly of the Biometrics Unit, Northern Forest Fire Laboratory, was most instructive in system design features, and Jack Cohen and Bob Burgan of the Fire Danger Research Work Unit were very helpful in the adaptation of NFDRS algorithms and subroutines.

A special thank you to Collin D. Bevins, Principal investigator for his continued patience and advice during the course of the year and to all the employees of Systems for Environmental Management for continued understanding of my frustration with computers.

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December 1978

STUDY PURPOSE

Fire planners need information at their disposal deliniating the occurrence probabilities and patterns of favorable burning conditions under various burning objectives, time periods, and prescription parameters throughout the calender year. This project was undertaken to establish a methodology of obtaining, evaluating, and presenting prescription occurrence information by a standardized, user-oriented computer system, and make it available throughout the National Forest System. Results are in the form of two computer programs, RXWTHR (RXWeaTHeR) and RXBURN at the USDA Forest Service's Fort Collins Computer Center (FCCC), Fort Collins, Colorado.

STUDY OBJECTIVES

The three objectives of the study were to;

(1) develop and document an operational computer program for defining and displaying the frequency of occurrence of certain combinations of weather conditions important for planning prescribed burning operations,

(2) to install the developed system at the USDA Forest Service, Fort Collins Computer Center, and

(3) to provide a users' guide containing complete instructions on how to access and prepare necessary input information for the system and how to interpret the results.

SYSTEM CONTRAINTS

Programs RXWTHR and RXBURN are designed to use archival data in the National Fire Weather Library (Furman and Brink, 1975). Gibson (1977) and others have noted a limitaion in the use of National Fire Weather Library (NFWL) records for planning prescribed burning-- observations are taken only once per day over the length of the fire season. This results in two contraints on any system that uses the data. First, the single observation must be considered to be representative of the entire day, when in fact it represents the 'typical worst' conditions (mid-afternoon, southwest aspect, mid-slope, open canopy). Second, weather observations are rarely recorded for more than five months annually during the 'fire season'. Data therefore tend to be scarce in pre- and post-fire season periods-- times that prescribed burning operations are generally most active.

SYSTEM DESIGN

Four qualities were considered necessary in the design of the system. The final product should (1) provide desired information in a succient form, (2) be flexible in output capabilities, (3) be easily accessed by users, and (4) make efficient use of computer time and storage.

To help insure usefulness the information is designed to fulfill certain needs of environmental information required by standard fire planning procedures (Fischer, 1978). Program RXWTHR displays basic climatological summary and co-occurrence tables of user-selected parameters, and program RXBURN displays occurrence statistics of local prescription conditions. Parameters included as program options were selected in conjunction with William C. Fischer, Northern Forest Fire Laboratory, and fire management officers on ranger districts that field tested and evaluated the programs.

In offering flexibility, the users may select from 16 prescription parameters for analysis by the programs, including 2 National Danger Rating System indices (Deeming and others, 1977). The National Fire Danger Rating System (NFDRS) is currently in use at over 1200 field locations in the United States. The programs offer three types of output, each with a specific purpose, allowing users to select output information specific to their needs. Also, program RXBURN allows two prescription ranges to be entered for each parameter specified in a prescription. These are defined as 'preferable' and 'acceptable' prescriptions and are fully detailed in the discussion on program RXBURN.

To facilitate accessibility, the programs have been stored in the Region 1 program library at FCCC. The programs are available via remote terminals, or batch processing units at more central locations. A complete users' guide (section 2) describes information needed to use the programs, how to get the information, program usage, and interpretation of results.

For efficiency, the system was designed as two independent software routines (RXWTHR and RXBURN) that should be used in conjunction with each other. There are two reasons for this design. First, results from use of RXWTHR should be used to aid initial selection of prescription limits for analysis by RXBURN. Secondly, the information produced by the statistical routines of RXWTHR require substanitallly more computer storage space (memory) and computation time that the prescription condition frequency analysis performed by RXBURN. Coupled with the fact that RXWTHR should be run only once or twice per station, versus RXBURN being run several times on one station for various prescription conditions, it is more efficient to have the system consist of two independent software routines.

To reduce computer storage requirements, program RXWTHR analyzes a maximum of 5 months of weather data from the National Fire Weather Library in a single run. This is usually not a limitation of the system since few stations have more than 5 months of data on file for each year. For those stations with more than 5 months of fire weather data, two or three runs of RXWTHR may be needed to obtain the desired climatological summaries. The 5 month restriction does not apply to program RXBURN.

Finally, the system provides the user the option of multiple prescription analysis, and multiple station analysis (up to 99) in a single run of RXWTHR or RXBURN. This results in substantial savings for system-users who are planning for multiple burning objectives over several fire weather station areas.

GENERAL PROGRAM FEATURES

Programs RXWTHR and RXBURN were constucted with the following features:

-- All FORTRAN IV code is ASCII standard.

-- 1978 NFDRS algorithms and subroutines were incorporated where applicable.

-- Both programs operate on simple input streams.

-- Both programs have input error checking routines that print out input stream error messages.

-- A site adjustment option allows adjustment of fuel moisture values to locations with elevation, aspect, and canopy cover different from those of the user-selected station.

-- Up to 99 stations may be processed during a single execution to save on computer costs.

-- A single station may be efficiently analyzed for several different prescriptions in the same run by the construction of a temporary disk file to hold first run computations.

-- A newly developed duff moisture model is available for test use (Fosberg, 1975). The model is based on theoretical considerations of water transport through the litter, duff, and soil horizons as affected by daily weather observations. The model is still in the validation stage, and results should be viewed as tentative.

-- Program RXBURN allows preferable and acceptable prescription entries.

PROGRAM RXWTHR

Program RXWTHR computes and displays summary tables for a maximum of 15 of the parameters listed in table 1. Figures 1 and 2 are examples of RXWTHR output. RXWTHR will also display up to 5 tables of percent frequency of co-occurrence for any of the parameters listed in table 1. Figures 3 and 4 exemplify output from this option of RXWTHR. Summary tables are computed by monthly and 10-day periods, co-occurrence tables are computed by monthly periods only.

Program RXWTHR is designed to give users a local climatological summary of fire weather and prescription parameters, and to permit a cursory investigation of the co-occurrence of user-selected prescription conditions (such as wind direction with wind speed, or temperature with relative humidity with 10 hour fuel moisture). RXWTHR summary and co-occurrence tables should aid fire and land managers in selecting prescriptions that have a high probability of meeting burning objectives, and an acceptable frequency of occurrence, without wasting time and money in guessing what range of values to analyze in RXBURN.

PROGRAM RXBURN

Program RXBURN computes and displays prescription occurrence frequencies of 'preferable', 'acceptable', and 'unacceptable' conditions. RXBURN has the unique feature of allowing two ranges of prescriptions to be entered for each prescription parameter. Users define prescriptions for analysis in RXBURN by entering a range of preferred burning conditions, and a second broader range of acceptable burning conditions. Values outside of the acceptable range are

Table 1: Parameters available for analysis in RXWTHR and RXBURN.

	PARAMETER	UNITS
1.	State of the Weather	
2.	Temperature (observation time)	F
3.	Relative Humidity (observation time)	%
4.	Wind Direction (observation time)	
5.	Wind Speed (10 minute average)	mph
6.	Maximum Temperature (last 24 hours)	F
7.	Mimimum Temperature (last 24 hours)	F
8.	Maximum Relative Humidity (last 24 hours)	%
9.	Mimimum Relative Humidity (last 24 hours)	%
** 10.	Precipitation Duration (last 24 hours)	hours
11.	Precipitation Amount (last 24 hours)	inches
12.	1 Hour Fuel Moisture (observation time)	%
13.	10 Hour Fuel Moisture (observation time)	%
14.	1978 NFDRS ERC (observation time)	
15.	1978 NFDRS BI (observation time)	
16.	Duff Moisture (24 hour average)	%

** In RXBURN Precipitation Duration is replaced by Days Since Last Measurable Precipitation.

Figure 1: RXWTHR Summary Table Format

10 DAY AND MONTHLY SUMMARIES OF ***TEMPERATURE ***

RELATIVE FREQUENCY OF OCCURRENCE OF DAILY VALUES (1500 MST)

DEMONSTRATION OF RXWTHR OUTPUT FOR PHILIPSBURG RANGER STATION

PHILIPSBURG RS (243002) 1960-1977

TEMPERATURE DEG F

[redacted]RIOD [redacted]GINS	BELOW 55	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 AND ABOVE	N. DAYS	MEAN	SD	MEDIAN	RANGE
MAY 1	54.9	11.8	11.8	12.7	2.0	5.9					102	54.2	11.5	52.2	34 - 79
MAY 11	39.8	17.5	14.3	13.0	8.3	5.5					108	57.2	10.9	55.9	30 - 79
[redacted] 21	31.4	18.5	20.3	12.7	11.0	5.1	.8				118	59.1	10.3	59.0	33 - 84
[redacted] 1	20.9	15.1	13.2	22.6	15.0	9.4	2.8				106	63.1	9.5	64.2	39 - 82
[redacted] 11	25.7	15.6	7.3	15.3	13.8	10.1	3.7	4.6			109	63.3	11.8	64.1	34 - 88
JUN 21	13.2	12.3	9.4	15.1	19.8	13.2	12.3	4.7			106	67.7	11.6	69.0	38 - 87
JUL 1	1.5	5.9	5.9	11.1	20.7	29.6	19.3	5.2		.7	135	73.9	8.0	74.8	52 - 95
[redacted] 11	1.3	5.3	6.7	11.3	15.3	23.3	22.0	11.3	3.3		150	75.1	9.1	76.1	48 - 92
[redacted] 21	.6	1.2	4.8	8.5	10.9	23.6	29.7	19.4	1.2		165	78.0	7.5	79.1	52 - 90
[redacted] 1	1.9	4.4	3.8	12.6	15.4	20.1	21.4	15.1	3.8	.5	159	76.4	9.2	76.7	50 - 95
AUG 11	2.1	4.1	6.2	9.6	13.0	19.9	23.3	21.2	.7		145	76.5	9.3	77.8	45 - 91
AUG 21	11.3	8.2	6.2	11.9	13.2	22.6	15.7	6.3	1.9	.5	159	70.7	11.6	72.9	41 - 95
SEP 1	17.6	12.5	15.9	7.4	18.4	14.0	9.6	2.9	.7		136	66.4	11.4	66.0	35 - 90
[redacted] 11	31.7	13.8	10.6	18.7	15.4	8.1	1.6				123	60.0	12.1	61.1	28 - 80
[redacted] 21	31.9	15.5	10.3	18.1	11.2	6.9	6.0				115	60.1	12.3	60.3	35 - 83
MAY	41.5	15.2	15.9	12.8	7.3	6.1	.3				328	56.9	11.1	56.6	30 - 84
[redacted]	19.9	14.6	10.0	18.7	15.5	10.9	6.2	3.1			321	64.7	11.2	65.5	34 - 88
[redacted]	1.1	4.0	6.8	10.2	15.3	25.3	24.0	12.4	1.5	.2	450	75.8	8.4	76.7	48 - 95
[redacted]	5.2	5.6	6.0	11.4	14.2	20.9	20.0	14.0	2.2	.4	464	74.5	10.5	75.8	41 - 95
SEP	26.7	13.9	12.8	14.4	15.2	9.9	5.9	1.1	.3		375	62.3	12.3	62.7	28 - 90

Figure 2: RXWTHR Summary Table Format for Wind Direction or State of Weather

10 DAY AND MONTHLY SUMMARIES OF ***WIND DIRECTION ***

RELATIVE FREQUENCY OF OCCURRENCE OF DAILY VALUES (1500 MST)

DEMONSTRATION OF RXWTHR OUTPUT FOR PHILIPSBURG RANGER STATION

PHILIPSBURG RS (243002) 1960-1977

WIND DIRECTION

PE[redacted]OD BE[redacted]NS	CALM	NE	E	SE	S	SW	W	NW	N	N. DAYS	MODE
MA[redacted] 1	2.0	8.8	2.0	2.0	2.9	27.5	18.6	29.4	6.9	102	NW
MA[redacted]11	1.9	8.3	1.9	1.9	1.9	23.1	19.4	27.8	13.9	108	NW
MA[redacted]21	.8	3.4	.8	2.5	.8	29.7	12.7	38.1	11.0	118	NW
JUN 1	1.9	5.7	3.3	4.7		18.9	15.1	40.6	9.4	105	NW
JUN 11	3.7	1.8	4.6	3.7	1.8	26.6	12.8	30.3	14.7	109	NW
JU[redacted]21	5.7	4.7	2.8	1.9	3.8	25.5	17.9	25.4	11.3	105	NW
JU[redacted] 1	2.2	5.9	2.2	3.0	.7	25.9	16.3	29.6	14.1	135	NW
JU[redacted]11	3.3	5.3	2.0	2.0	7.3	22.0	15.3	27.3	15.3	150	NW
JU[redacted]21	1.2	4.8	1.2	2.4	3.0	20.6	20.0	37.6	9.1	165	NW
AUG 1	1.9	9.4	1.3	4.4	1.9	30.2	12.6	30.8	7.5	159	NW
AUG 11	2.7	1.4	1.4	1.4	1.4	28.1	17.8	39.7	6.2	145	NW
AU[redacted]21	2.5	3.3	.5	2.5	3.8	22.6	18.9	32.7	7.5	159	NW
SE[redacted] 1	3.7	7.4		.7	4.4	27.9	18.4	25.7	11.8	135	SW
SE[redacted]11	2.4	10.6	1.6	4.1	3.3	17.9	15.4	29.3	15.4	123	NW
SEP 21	6.0	4.3		2.6	5.2	23.3	29.3	17.2	12.1	115	W
MA[redacted]	1.5	5.7	1.5	2.1	1.8	26.8	16.8	32.0	10.7	328	NW
JU[redacted]	3.7	4.0	3.7	3.4	1.9	23.7	15.3	32.4	11.8	321	NW
J[redacted]	2.2	5.3	1.8	2.4	3.8	22.7	17.3	31.8	12.7	450	NW
AUG	2.4	5.0	1.1	2.8	4.1	25.9	16.4	34.3	7.1	464	NW
SEP	4.0	7.5	.5	2.4	4.3	23.2	20.8	24.3	13.1	375	NW

Figure 3: RXWTHR 2-Way Co-occurrence Table Format

WIND DIRECTION - WIND SPEED

PERCENT FREQUENCY OF CO-OCCURRENCE
GIVEN TO TENTHS PERCENT

PHILIPSBURG RS (243002) 1960-1977

DEMONSTRATION OF RXWTHR OUTPUT FOR PHILIPSBURG RANGER STATION

** MAY **

WIND D	WIND SPEED BELOW 3	3 TO 5	6 TO 8	9 TO 11	12 TO 14	15 TO 17	MPH 18 TO 20	21 TO 23	24 TO 27	28 AND ABOVE	TOTAL
CALM	1.5										1.5
NE	2.7	1.8	.3	1.2		.3		.3			6.7
E	.3	.6	.3		.3						1.5
SE	.3	.9	.6		.3						2.1
S	.3	.3	.3	.9							1.8
SW	.9	9.8	5.2	4.3	3.7	2.1	.9				26.8
W	1.9	1.8	6.7	2.1	3.4	.9					16.8
NW	1.5	9.5	7.9	4.9	3.7	3.7	.6	.3			32.0
N	.3	1.5	3.0	3.0	1.8	.5	.3				10.7
TOTAL	9.8	26.2	24.4	16.5	13.1	7.5	1.8	.6	0.0	0.0	100.0

NUMBER OF DAYS 328

** JUN **

WIND D	WIND SPEED BELOW 3	3 TO 5	6 TO 8	9 TO 11	12 TO 14	15 TO 17	MPH 18 TO 20	21 TO 23	24 TO 27	28 AND ABOVE	TOTAL
CALM	3.7										3.7
NE	.3	1.9	.6	.9	.3						4.0
E	.3	.9	1.2	.9	.3						3.7
SE	.6	1.2	.6	.3		.5					3.4
S		.9	.3		.6						1.9
SW	5.0	6.5	3.1	4.4	1.9	1.2	1.6				23.7
W	.6	4.7	2.8	3.1	3.7	.3					15.3
NW	2.8	7.8	9.0	6.9	5.0	.5	.3				32.4
N	.3	2.2	4.0	1.6	.9	2.5			.3		11.8
TOTAL	13.7	25.2	21.8	18.1	12.4	5.3	1.9	0.0	.3	0.0	100.0

NUMBER OF DAYS 321

Figure 4: RXWTHR 3-Way Co-occurrence Table Format

TEMPERATURE - RELATIVE HUMIDITY - WIND SPEED

PERCENT FREQUENCY OF CO-OCCURRENCE, GIVEN TO TENTHS PERCENT

PHILIPSBURG RS (243002)
** MAY ** 1950-1977

DEMONSTRATION OF RXWTHR OUTPUT FOR PHILIPSBURG RANGER STATION

WIND SPEED LT 6 MPH

TEMP DEG F	BELOW 10	10 TO 19	20 TO 29	30 TO 39	40 TO 49	50 TO 59	60 TO 69	70 TO 79	80 TO 89	90 AND ABOVE
LT 55				.6	1.7	3.7	1.2	3.4	2.4	3.0
55 - 59			.6	.6	2.4	1.2	.6		.3	
60 - 64			.6	1.9	1.8	.6	.3	.3		
65 - 69			1.2	2.1	.5		.3			
70 - 74		.6	.9	.6		.3				
75 - 79		.3	1.2		.3					
80 - 84		.3								
85 - 89										
90 - 94										
GE 95										
TOTAL	0.0	1.2	4.6	5.8	6.7	5.8	2.4	3.7	2.7	3.0

WIND SPEED 6 - 11 MPH

TEMP DEG F	BELOW 10	10 TO 19	20 TO 29	30 TO 39	40 TO 49	50 TO 59	60 TO 69	70 TO 79	80 TO 89	90 AND ABOVE
LT 55			.3	1.2	3.4	2.4	3.7	3.0	2.1	.9
55 - 59		.6	.9	3.4	1.2	.3	.3			
60 - 64		.3	1.5	2.7	.6	.9				
65 - 69		.6	1.8	1.2	.9					
70 - 74		.3	1.8	.9	.3					
75 - 79		1.5	1.2	.3						
80 - 84										
85 - 89										
90 - 94										
GE 95										
TOTAL	0.0	3.4	7.6	9.8	6.4	3.7	4.0	3.0	2.1	.9

WIND SPEED 12 - 17 MPH

TEMP	BELOW 10	10 TO 19	20 TO 29	30 TO 39	40 TO 49	50 TO 59	60 TO 69	70 TO 79	80 TO 89	90 AND ABOVE
LT 55				.9	1.8	.9	1.5	1.2	.9	
55 - 59			.6	.7	.9	.6	.3			
60 - 64	.3		.9	1.2	.6		.3	.3		
65 - 69			.9	1.8	.3	.3		.3		
70 - 74			1.5							
75 - 79			1.2							
80 - 84										
85 - 89										
90 - 94										
GE 95										
TOTAL	.3	0.0	5.2	4.9	3.7	1.8	2.1	1.8	.9	0.0

WIND SPEED 18 - 23 MPH

TEMP	BELOW 10	10 TO 19	20 TO 29	30 TO 39	40 TO 49	50 TO 59	60 TO 69	70 TO 79	80 TO 89	90 AND ABOVE
LT 55				.3	.3		.3	.3		
55 - 59				.3						
60 - 64				.3		.3				
65 - 69				.3						
70 - 74										
75 - 79										
80 - 84										
85 - 89										
90 - 94										
GE 95										
TOTAL	0.0	0.0	0.0	1.2	.3	.3	.3	.3	0.0	0.0

WIND SPEED GE 24 MPH

TEMP	BELOW 10	10 TO 19	20 TO 29	30 TO 39	40 TO 49	50 TO 59	60 TO 69	70 TO 79	80 TO 89	90 AND ABOVE	TOTAL
LT 55											41.5
55 - 59											16.2
60 - 64											15.9
65 - 69											12.8
70 - 74											7.3
75 - 79											6.1
80 - 84											.3
85 - 89											0.0
90 - 94											0.0
GE 95											0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

NUMBER OF DAYS 328

considered in RXBURN as 'unacceptable' burning conditions.

RXBURN execution analyzes a maximum of 15 simultaneous prescription conditions for frequency and patterns of co-occurrence. Available parameters are the same as for RXWTHR (table 1), with the exception of precipitation duration which is replaced by the number of days since last measurable precipitation. Program RXBURN produces the following output:

(1) a prescription occurrence summary (figure 5). The average number of days per season of preferable, acceptable, and unacceptable prescription conditions, percent frequency of occurrence of each presciption, the month, and 10-day period of highest frequency of occurrence are tabulated;

(2) a seasonal progression of prescription frequencies (figure 6). The total number of sample days, mean number of prescription days, and percent frequency of occurrence are tabulated by 10-day, monthly, and seasonal stratifications;

(3) a run length summary (figure 7). The mean duration of days in each prescription condition by 10-day and monthly period, and the value of the duration length at the 25th, 50th (median), and 75th percentiles are tabulated; and

(4) a persistence and transition probability matrix (figure 8). Persistence and transition probabilites are displayed for 1, 2, and 3 days ahead given an initial prescription type, by use of a simple Markov chain model for each monthly period.

Figure 5: RXBURN Prescription Summary Page Format

PROGRAM RXBURN: RUN NO. 1 DISTRICT: FIRE LAB FOREST: MONTANA PAGE NO. 1

DEMONSTRATION OF RXBURN OUTPUT FOR PHILPSBURG RANGER STATION

AFFIRMS STATION NAME: PHILIPSBURG RS	NATIONAL FOREST: MONTANA
STATION NUMBER: 243002	DISTRICT: FIRE LAB
ELEVATION FT MSL: 5280	USER: LARRY BRADSHAW

YEARS OF WEATHER DATA REQUESTED: 1960 TO 1977 (18 YEARS)
SEASONAL DATES OF ANALYSIS : MAY 1 TO NOV 1
TOTAL DAYS AVAILABLE : 2196 DAYS OVER 16 YEARS

PRESCRIPTION FACTOR SUMMARY

PRESCRIPTION FACTORS	PREFERABLE CONDITIONS		ACCEPTABLE CONDITIONS	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
1. TEMPERATURE (DEG F)	65	75	60	80
2. RELATIVE HUMIDITY (%)	20	30	20	55
3. WIND SPEED (MPH)	4	9	0	15

PRESCRIPTION OCCURRENCE SUMMARY

	PREFERABLE	ACCEPTABLE	UNACCEPTABLE
DAYS PER SEASON WITHIN PRESCRIPTION	8	51	79
(PERCENT)	5%	37%	58%
MONTH OF HIGHEST PRESCRITION FREQUENCY	SEP	JUL	OCT
(PERCENT PROBABILITY)	9%	45%	71%
10 DAY PERIOD OF HIGHEST RX FREQUENCY BEGINS	JUN 1 OCT 1	JUL 1	MAY 1
(PERCENT PROBABILITY)	10%	56%	78%

Figure 6: RXBURN Seasonal Progression of Prescription Frequencies Format

PROGRAM RXBURN: RUN NO. 1 DISTRICT: FIRE LAB FOREST: MONTANA PAGE NO. 2

PRESCRIPTION OCCURRENCE BY 10 DAY PERIOD AND MONTH

MONTH	PERIOD BEGINS	NO. DAYS	PREFERABLE DAYS MEAN	PREFERABLE DAYS NUMBER	PREFERABLE DAYS PERCENT	ACCEPTABLE DAYS MEAN	ACCEPTABLE DAYS NUMBER	ACCEPTABLE DAYS PERCENT	UNACCEPTABLE DAYS MEAN	UNACCEPTABLE DAYS NUMBER	UNACCEPTABLE DAYS PERCENT
MAY	1	102	0	4	4%	1	18	18%	5	80	78%
MAY	11	108	0	5	5%	2	32	30%	4	71	66%
MAY	21	118	1	8	7%	3	40	34%	4	70	59%
MAY	TOTAL	328	1	17	5%	6	90	27%	14	221	67%
JUN	1	106	1	11	10%	3	48	45%	3	47	44%
JUN	11	109	0	4	4%	2	39	36%	4	66	61%
JUN	21	106	0	6	6%	3	45	42%	3	55	52%
JUN	TOTAL	321	1	21	7%	8	132	41%	11	168	52%
JUL	1	135	0	3	2%	5	76	56%	4	56	41%
JUL	11	150	1	8	5%	4	62	41%	5	80	53%
JUL	21	165	0	5	3%	4	63	38%	6	97	59%
JUL	TOTAL	450	1	16	4%	13	201	45%	15	233	52%
AUG	1	159	0	7	4%	4	66	42%	5	86	54%
AUG	11	146	0	3	2%	4	56	38%	5	87	60%
AUG	21	159	1	10	6%	4	67	42%	5	82	52%
AUG	TOTAL	464	1	20	4%	12	189	41%	16	255	55%
SEP	1	136	1	12	9%	3	55	40%	4	69	51%
SEP	11	123	1	11	9%	3	42	34%	4	70	57%
SEP	21	116	1	11	9%	2	39	34%	4	66	57%
SEP	TOTAL	375	2	34	9%	9	136	36%	13	205	55%
OCT	1	90	1	9	10%	1	20	22%	4	61	68%
OCT	11	90	0	3	3%	1	21	23%	4	66	73%
OCT	21	79	0	0	0%	1	22	28%	4	56	72%
OCT	TOTAL	258	1	12	5%	4	63	24%	11	183	71%
NOV	TOTAL	0	0	0	0%	0	0	0%	0	0	0%
TOTAL	TOTAL	2196	8	120	5%	51	811	37%	79	1265	58%

Figure 7: RXBURN Prescription Run Length Format

PROGRAM RXBURN: RUN NO. 1 DISTRICT: FIRE LAB FOREST: MONTANA PAGE NO. 3

PRESCRIPTION RUN LENGTH SUMMARY

		** PREFERABLE DAY RUNS				** ACCEPTABLE DAY RUNS				** UNACCEPTABLE DAY RUNS			
	PERIOD		* PERCENTILES *				* PERCENTILES *				* PERCENTILES *		
MONTH	BEGINS	MEAN	25TH	MEDIAN	75TH	MEAN	25TH	MEDIAN	75TH	MEAN	25TH	MEDIAN	75TH
MAY	1	2	1	1	3	1	1	1	2	4	2	4	7
MAY	11	1	1	1	1	2	1	2	2	3	1	2	5
MAY	21	1	1	1	1	2	1	1	2	3	1	2	5
MAY	TOTAL	1	1	1	1	2	1	1	2	4	1	3	8
JUN	1	2	1	1	2	2	1	1	3	2	1	2	3
JUN	11	1	1	1	1	2	2	2	2	3	1	2	5
JUN	21	1	1	1	1	2	1	1	2	3	1	2	4
JUN	TOTAL	1	1	1	1	2	1	2	3	3	1	2	5
JUL	1	1	1	1	1	2	1	2	3	2	1	1	2
JUL	11	1	1	1	1	2	1	1	2	2	1	1	3
JUL	21	1	1	1	1	2	1	1	2	3	1	2	4
JUL	TOTAL	1	1	1	1	2	1	1	2	2	1	2	3
AUG	1	1	1	1	1	2	1	1	2	2	1	2	3
AUG	11	1	1	1	1	2	1	1	3	3	1	2	4
AUG	21	1	1	1	1	2	1	1	2	2	1	2	3
AUG	TOTAL	1	1	1	1	2	1	1	3	3	1	2	3
SEP	1	1	1	1	1	2	1	1	2	2	1	2	2
SEP	11	1	1	1	1	2	1	2	2	3	1	2	5
SEP	21	1	1	1	1	2	1	1	2	3	1	2	3
SEP	TOTAL	1	1	1	1	2	1	1	2	3	1	2	4
OCT	1	1	1	1	1	1	1	1	2	3	1	2	4
OCT	11	2	1	1	2	2	1	1	3	4	2	3	6
OCT	21	0	0	0	0	2	1	1	2	2	1	1	2
OCT	TOTAL	1	1	1	1	2	1	1	2	4	1	2	5
NOV	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0

Figure 8: RXBURN Prescription Persistence and Transition Probability Format

PROGRAM RXBURN: RUN NO. 1 DISTRICT: FIRE LAB FOREST: MONTANA PAGE NO. 4

PROBABILITY OF MEETING PRESCRIPTION 1, 2, AND 3 DAYS IN THE FUTURE

MONTH: MAY

TODAYS	*** TOMORROW ***			**** 2 DAYS ****			**** 3 DAYS ****			N DAYS	
COND	PREF	ACCP	UNAC	PREF	ACCP	UNAC	PREF	ACCP	UNAC		
PREF	12%	53%	35%	9%	37%	54%	7%	32%	62%	PREF	17
ACCP	12%	46%	42%	8%	35%	57%	6%	31%	63%	ACCP	84
UNAC	2%	18%	80%	4%	24%	72%	5%	26%	69%	UNAC	215

MONTH: JUN

TODAYS	*** TOMORROW ***			**** 2 DAYS ****			**** 3 DAYS ****			N DAYS	
COND	PREF	ACCP	UNAC	PREF	ACCP	UNAC	PREF	ACCP	UNAC		
PREF	20%	60%	20%	10%	51%	39%	8%	45%	47%	PREF	20
ACCP	9%	55%	35%	8%	46%	45%	7%	43%	50%	ACCP	130
UNAC	3%	28%	69%	5%	37%	58%	6%	40%	54%	UNAC	171

MONTH: JUL

TODAYS	*** TOMORROW ***			**** 2 DAYS ****			**** 3 DAYS ****			N DAYS	
COND	PREF	ACCP	UNAC	PREF	ACCP	UNAC	PREF	ACCP	UNAC		
PREF	0%	75%	25%	4%	48%	48%	3%	45%	52%	PREF	16
ACCP	4%	51%	44%	3%	46%	51%	3%	44%	52%	ACCP	204
UNAC	3%	35%	62%	3%	42%	54%	3%	44%	53%	UNAC	226

PROGRAM TESTING AND USER INTERFACING

Programs RXWTHR and RXBURN were tested and interfaced with fire planning activities on several ranger districts in Region 1, USDA Forest Service. Most helpful were Dan Baily and Kathy Davis of the Troy district, Koonenai National Forest. Other fire management officers who participated in testing these programs were:

(1) Russ Gripp, Idaho Panhandle National Forest;

(2) John Roberts, Missoula District, Lolo National Forest;

(3) Dave Bunnell, Lolo National Forest;

(4) Dick Schulty, Libby District, Koontenai National Forest; and

(5) Floyd Bethke, Deerlodge National Forest.

Response to the information content and format was generally quite favorable. Managers seemed most interested in the average number of burning days and the corresponding percent frequency of occurrence in RXBURN. In RXWTHR the most favorable response was from the information provided by the summary tables. Less interest was displayed in the co-occurrence tables of RXWTHR and the run length and persistence displays of RXBURN. The two most often expressed concerns dealt with prescription frequencies for periods before and after fire weather stations are in operation, and projecting prescription conditions to locations differing from the base weather station.

The second concern resulted in the addition of research done for Fire Behavior Officer (FBO) training courses in the form of the site adjustment factors as described earlier. The first concern lead to an attempt to supplement the short based fire weather data base year-round data from the National Climatic Center. This work is being performed in a companion study.

SPECIAL TOPICS

DUFF MOISTURE

Norum (1977) has shown that duff moisture content of the forest floor has a significant effect on prescribed fire and the probability of meeting burning objectives in western larch/douglas-fir forests. The feasibility of using NFDRS indices and fuel moisture values as indicators or predictors of average duff moisture values was investigatied as a part of this project. Relationships of duff moisture contents with on-site weather observations and resulting NFDRS indices were developed from Norum's prescription burning data in the Luebrecht Experimental Forest, and from data collected in the USDA Forest Service broadcast burning studies at Miller Creek-Newman Ridge (Beaufait and others, 1978). Both studies were conducted in northwest Montana.

Resulting relationships were weak at best (r^2=.51; entering 10, 100, 1000, hour fuel moisture, BI, and ERC in stepwise multiple regression) and the empirical approach was dropped as a method for prediction of duff moisture. Regardless, empirically derived relationships may have been strictly site specific to the Luebrecht and Miller Creek areas and their forest floor horizons.

As an alternative approach, a theoretical duff moisture model (Fosberg, 1975; Fosberg, 1977) was adopted for use in the system. Model development progressed sufficiently to incorporate an unvalidated version into programs RXWTHR and RXBURN. Validation attempts are scheduled for the summer of 1979. Results from using the duff model projections should therefore be regarded as preliminary and used with appropiate caution. The duff moisture model development is also being performed in a companion study by Systems for Environmental Management and will be fully documented in that study.

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SECTION 2

Program RXWTHR and Program RXBURN

USERS' GUIDE

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PREFACE TO SECTION 2

Section 2 is the Users' Guide for programs RXWTRH and RXBURN. It is intended as a stand alone paper and contains some information that is redundant to that presented in section 1 of the final report. Upon revision, the Users' Guide will be available as a USDA Forest Service Publication.

The Users's Guide is composed of three parts. The first part briefly discusses programs RXWTHR and RXBURN and defines the data base and information needed for program use. The second part details program use with demonstrations of both routines and a discussion of the output. The third part of this section details the use of special program options and give examples of their use.

INTRODUCTION TO PROGRAMS RXWTHR AND RXBURN

What are programs RXWTHR and RXBURN ?

Programs RXWTHR (RXWeaTHeR) and RXBURN are two seperate software routines available through the USDA Forest Service, Fort Collins Computer Center, that are designed to provide fire management personnel two types of information useful in planning prescibed fire.

What information do they provide ?

Program RXWTHR provides climatological summaries of user-selected fire weather parameters. Available parameters are listed in table 1. Examples of output available from program RXWTHR are displayed in figures 1 through 4.

Program RXBURN provides analysis of local prescription condition frequencies based on user-defined prescription conditions. Parameters available for inclusion as prescription conditions are listed in table 2, and up to 15 of the parameters may be included in a single prescription. Output from RXBURN is exemplified in figures 5 through 8.

How can the information be used ?

The programs are designed to provide specific information needed in both fire planning and prescribed burning. They provide local climatic information which is useful in many phases of forest management plannning, and specifically produce information recommended in making presscription fire plans (Fischer, 1978).

Table 1: Parameters available for analysis in RXWTHR summary and co-occurrence tables.

PARAMETER

1. State of the Weather
2. Temperature
3. Relative Humidity
4. Wind Direction
5. Wind Speed
6. Maximum Temperature (last 24 hours)
7. Minimum Temperature (last 24 hours)
8. Maximum Relative Humidity (last 24 hours)
9. Minimum Relative Humidity (last 24 hours)
10. Precipitation Duration (last 24 hours)
11. Precipitation Amount (last 24 hours)
12. 1 Hour Fuel Moisture
13. 10 Hour Fuel Moisture
14. 1978 NFDRS ERC (with selected NFDRS fuel models)
15. 1978 NFDRS BI (with selected NFDRS fuel models)
16. Duff Moisture (24 hour average for entire layer)

Table 2: Parameters available for inclusion as burning prescription condition in program RXBURN.

PARAMETER

1. State of the Weather
2. Temperature
3. Relative Humidity
4. Wind Direction
5. Wind Speed
6. Maximum Temperature (last 24 hours)
7. Minimum Temperature (last 24 hours)
8. Maximum Relative Humidity (last 24 hours)
9. Minimum Relative Humidity (last 24 hours)
10. Number of Days Since Last Measurable Precipitation
11. Precipitation Amount (last 24 hours)
12. 1 Hour Fuel Moisture
13. 10 Hour Fuel Moisture
14. 1978 NFDRS ERC (with selected NFDRS fuel models)
15. 1978 NFDRS BI (with selected NFDRS fuel models)
16. Duff Moisture (24 hour average for entire layer)

Figure 1: RXWTHR Summary Table Format

10 DAY AND MONTHLY SUMMARIES OF ***TEMPERATURE ***

RELATIVE FREQUENCY OF OCCURRENCE OF DAILY VALUES (1500 MST)

DEMONSTRATION OF RXWTHR OUTPUT FOR PHILIPSBURG RANGER STATION

PHILIPSBURG RS (243002) 1960-1977

TEMPERATURE DEG F

PERIOD BEGINS	BELOW 55	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 AND ABOVE	N. DAYS	MEAN	SD	MEDIAN	RANGE
MAY 1	54.9	11.8	11.8	12.7	2.0	6.9					102	54.2	11.5	52.2	34 - 79
MAY 11	39.8	17.6	14.8	13.0	8.3	6.5					108	57.2	10.9	56.9	30 - 79
MAY 21	31.4	18.6	20.3	12.7	11.0	5.1	.8				118	59.1	10.3	59.0	33 - 84
JUN 1	20.8	15.1	13.2	22.6	15.0	9.4	2.9				106	63.1	9.5	64.2	39 - 82
JUN 11	25.7	15.6	7.3	18.3	13.9	10.1	3.7	4.6			109	63.3	11.9	64.1	34 - 88
JUN 21	13.2	12.3	9.4	15.1	19.8	13.2	12.3	4.7			106	67.7	11.6	69.0	38 - 87
JUL 1	1.5	5.9	5.9	11.1	20.7	29.6	19.3	5.2		.7	135	73.9	8.0	74.8	52 - 95
JUL 11	1.3	5.3	6.7	11.3	15.3	23.3	22.0	11.3	3.3		150	75.1	9.1	76.1	48 - 92
JUL 21	.6	1.2	4.8	8.5	10.9	23.6	29.7	19.4	1.2		165	78.0	7.5	79.1	52 - 90
AUG 1	1.9	4.4	3.8	12.6	15.4	20.1	21.4	15.1	3.8	.6	159	75.4	9.2	76.7	50 - 95
AUG 11	2.1	4.1	6.2	9.6	13.0	19.9	23.3	21.2	.7		145	76.5	9.3	77.9	45 - 91
AUG 21	11.3	3.2	3.2	11.9	13.2	22.6	15.7	6.3	1.9	.6	159	70.7	11.6	72.9	41 - 95
SEP 1	17.6	12.5	15.9	7.4	18.4	14.0	9.6	2.9	.7		136	65.4	11.4	66.0	35 - 90
SEP 11	31.7	13.8	10.6	13.7	15.4	8.1	1.6				123	60.0	12.1	61.1	28 - 80
SEP 21	31.9	15.5	10.3	18.1	11.2	6.9	6.0				116	60.1	12.3	60.3	35 - 83
MAY	41.5	15.2	15.9	12.8	7.3	6.1	.3				329	56.9	11.1	55.6	30 - 84
JUN	19.9	14.6	10.0	18.7	15.5	10.9	6.2	3.1			321	64.7	11.2	65.5	34 - 88
JUL	1.1	4.0	5.3	10.2	15.3	25.3	24.0	12.4	1.6	.2	450	75.8	8.4	75.7	48 - 95
AUG	5.2	5.6	6.0	11.4	14.2	20.9	20.0	14.0	2.2	.4	464	74.5	10.5	75.8	41 - 95
SEP	26.7	13.9	12.8	14.4	15.2	9.9	5.9	1.1	.3		375	62.3	12.3	62.7	28 - 90

Figure 2: RXWTHR Summary Table Format for Wind Direction or State of Weather

10 DAY AND MONTHLY SUMMARIES OF ***WIND DIRECTION ***

RELATIVE FREQUENCY OF OCCURRENCE OF DAILY VALUES (1500 MST)

DEMONSTRATION OF RXWTHR OUTPUT FOR PHILIPSBURG RANGER STATION

PHILIPSBURG RS (243002) 1960-1977

WIND DIRECTION

PERIOD BEGINS	CALM	NE	E	SE	S	SW	W	NW	N	N. DAYS	MODE
MAY 1	2.0	8.8	2.0	2.0	2.9	27.5	18.6	29.4	6.9	102	NW
MAY 11	1.9	3.3	1.9	1.9	1.9	23.1	19.4	27.8	13.9	108	NW
MAY 21	.8	3.4	.8	2.5	.8	29.7	12.7	38.1	11.0	118	NW
JUN 1	1.9	5.7	3.8	4.7		18.9	15.1	40.6	9.4	106	NW
JUN 11	3.7	1.8	4.6	3.7	1.8	25.6	12.8	30.3	14.7	109	NW
JUN 21	5.7	4.7	2.8	1.9	3.8	25.5	17.9	25.4	11.3	106	NW
JUL 1	2.2	5.9	2.2	3.0	.7	25.9	16.3	29.6	14.1	135	NW
JUL 11	3.3	5.3	2.0	2.0	7.3	22.0	15.3	27.3	15.3	150	NW
JUL 21	1.2	4.8	1.2	2.4	3.0	20.6	20.0	37.6	9.1	165	NW
AUG 1	1.9	9.4	1.3	4.4	1.9	30.2	12.6	30.8	7.5	159	NW
AUG 11	2.7	1.4	1.4	1.4	1.4	28.1	17.8	39.7	6.2	145	NW
AUG 21	2.5	3.3	.6	2.5	3.8	22.6	18.9	32.7	7.5	159	NW
SEP 1	3.7	7.4		.7	4.4	27.9	18.4	25.7	11.8	136	SW
SEP 11	2.4	10.6	1.6	4.1	3.3	17.9	15.4	29.3	15.4	123	NW
SEP 21	6.0	4.3		2.6	5.2	23.3	29.3	17.2	12.1	116	W
MAY	1.5	5.7	1.5	2.1	1.8	25.8	15.8	32.0	10.7	329	NW
JUN	3.7	4.0	3.7	3.4	1.9	23.7	15.3	32.4	11.8	321	NW
JUL	2.2	5.1	1.3	2.4	3.8	22.7	17.3	31.8	12.7	450	NW
AUG	2.4	5.0	1.1	2.3	4.1	25.9	15.4	34.3	7.1	464	NW
SEP	4.0	7.5	.5	2.4	4.3	23.2	20.4	24.3	13.1	375	NW

Figure 3: RXWTHR 2-Way Co-occurrence Table Format

WIND DIRECTION - WIND SPEED

PERCENT FREQUENCY OF CO-OCCURRENCE
GIVEN TO TENTHS PERCENT

PHILIPSBURG RS (243002) 1960-1977

DEMONSTRATION OF RXWTHR OUTPUT FOR PHILIPSBURG RANGER STATION

** MAY **

WIND D	BELOW 3	3 TO 5	6 TO 8	9 TO 11	12 TO 14	15 TO 17	18 TO 20	21 TO 23	24 TO 27	28 AND ABOVE	TOTAL
CALM	1.5										1.5
NE	2.7	1.8	.3	1.2		.3		.3			6.7
E	.3	.6	.3		.3						1.5
SE	.3	.9	.6		.3						2.1
S	.3	.3	.3	.9							1.8
SW	.9	9.8	5.2	4.3	3.7	2.1	.9				26.8
W	1.9	1.8	6.7	2.1	3.4	.9					16.8
NW	1.5	9.5	7.9	4.9	3.7	3.7	.6	.3			32.0
N	.3	1.5	3.0	3.0	1.8	.5	.3				10.7
TOTAL	9.8	26.2	24.4	16.5	13.1	7.5	1.8	.6	0.0	0.0	100.0

WIND SPEED MPH; NUMBER OF DAYS 328

** JUN **

WIND D	BELOW 3	3 TO 5	6 TO 8	9 TO 11	12 TO 14	15 TO 17	18 TO 20	21 TO 23	24 TO 27	28 AND ABOVE	TOTAL
CALM	3.7										3.7
NE	.3	1.9	.6	.9	.3						4.0
E	.3	.9	1.2	.9	.3						3.7
SE	.6	1.2	.6	.3		.5					3.4
S		.9	.3		.6						1.9
SW	5.0	6.5	3.1	4.4	1.9	1.2	1.6				23.7
W	.6	4.7	2.8	3.1	3.7	.3					15.3
NW	2.8	7.8	9.0	6.9	5.0	.5	.3				32.4
N	.3	2.2	4.0	1.5	.9	2.5			.3		11.8
TOTAL	13.7	25.2	21.8	18.1	12.8	5.3	1.9	0.0	.3	0.0	100.0

WIND SPEED MPH; NUMBER OF DAYS 321

Figure 4: RXWTHR 3-Way Co-occurrence Table Format

TEMPERATURE - RELATIVE HUMIDITY - WIND SPEED

PERCENT FREQUENCY OF CO-OCCURRENCE, GIVEN TO TENTHS PERCENT

PHILIPSBURG RS (243002)
** MAY ** 1960-1977

DEMONSTRATION OF RXWTHR OUTPUT FOR PHILIPSBURG RANGER STATION

WIND SPEED LT 6 MPH — RELATIVE HUMIDITY

TEMP DEG F	BELOW 10	10 TO 19	20 TO 29	30 TO 39	40 TO 49	50 TO 59	60 TO 69	70 TO 79	80 TO 89	90 AND ABOVE
LT 55				.6	1.5	3.7	1.2	3.4	2.4	3.0
55 - 59			.6	.6	2.4	1.2	.6		.3	
60 - 64			.6	1.9	1.8	.6	.3	.3		
65 - 69			1.2	2.1	.5		.3			
70 - 74		.5	.9	.6		.3				
75 - 79		.3	1.2		.3					
80 - 84		.3								
85 - 89										
90 - 94										
GE 95										
TOTAL	0.0	1.2	4.6	5.8	6.7	5.8	2.4	3.7	2.7	3.0

WIND SPEED 6 - 11 MPH — RELATIVE HUMIDITY

TEMP DEG F	BELOW 10	10 TO 19	20 TO 29	30 TO 39	40 TO 49	50 TO 59	60 TO 69	70 TO 79	80 TO 89	90 AND ABOVE
LT 55			.3	1.2	3.4	2.4	3.7	3.0	2.1	.9
55 - 59		.6	.9	3.4	1.2	.3	.3			
60 - 64		.3	1.5	2.7	.6	.9				
65 - 69		.6	1.8	1.2	.9					
70 - 74		.3	1.8	.9	.3					
75 - 79		1.5	1.2	.3						
80 - 84										
85 - 89										
90 - 94										
GE 95										
TOTAL	0.0	3.4	7.6	9.8	6.4	3.7	4.0	3.0	2.1	.9

WIND SPEED 12 - 17 MPH

TEMP										
LT 55				.9	1.8	.9	1.5	1.2	.9	
55 - 59			.6	.7	.9	.6	.3			
60 - 64	.3		.9	1.2	.5		.3	.3		
65 - 69			.9	1.8	.3	.3		.3		
70 - 74			1.5							
75 - 79			1.2							
80 - 84										
85 - 89										
90 - 94										
GE 95										
TOTAL	.3	0.0	5.2	4.9	3.7	1.9	2.1	1.8	.9	0.0

WIND SPEED 18 - 23 MPH

TEMP										
LT 55				.3	.3		.3	.3		
55 - 59				.3						
60 - 64				.3		.3				
65 - 69				.3						
70 - 74										
75 - 79										
80 - 84										
85 - 89										
90 - 94										
GE 95										
TOTAL	0.0	0.0	0.0	1.2	.3	.3	.3	.3	0.0	0.0

WIND SPEED GE 24 MPH

TEMP											TOTAL
LT 55											41.5
55 - 59											16.2
60 - 64											15.9
65 - 69											12.8
70 - 74											7.3
75 - 79											6.1
80 - 84											.3
85 - 89											0.0
90 - 94											0.0
GE 95											0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

NUMBER OF DAYS 328

Figure 5: RXBURN Prescription Summary Page Format

PROGRAM RXBURN: RUN NO. 1 DISTRICT: FIRE LAB FOREST: MONTANA PAGE NO. 1

DEMONSTRATION OF RXBURN OUTPUT FOR PHILPSBURG RANGER STATION

AFFIRMS STATION NAME: PHILIPSBURG RS
STATION NUMBER: 243002
ELEVATION FT MSL: 5280

NATIONAL FOREST: MONTANA
DISTRICT: FIRE LAB
USER: LARRY BRADSHAW

YEARS OF WEATHER DATA REQUESTED: 1960 TO 1977 (18 YEARS)
SEASONAL DATES OF ANALYSIS : MAY 1 TO NOV 1
TOTAL DAYS AVAILABLE : 2196 DAYS OVER 16 YEARS

PRESCRIPTION FACTOR SUMMARY

PRESCRIPTION FACTORS	PREFERABLE CONDITIONS MINIMUM	PREFERABLE CONDITIONS MAXIMUM	ACCEPTABLE CONDITIONS MINIMUM	ACCEPTABLE CONDITIONS MAXIMUM
1. TEMPERATURE (DEG F)	65	75	60	80
2. RELATIVE HUMIDITY (%)	20	30	20	55
3. WIND SPEED (MPH)	4	9	0	15

PRESCRIPTION OCCURRENCE SUMMARY

	PREFERABLE	ACCEPTABLE	UNACCEPTABLE
DAYS PER SEASON WITHIN PRESCRIPTION	8	51	79
(PERCENT)	5%	37%	58%
MONTH OF HIGHEST PRESCRITION FREQUENCY	SEP	JUL	OCT
(PERCENT PROBABILITY)	9%	45%	71%
10 DAY PERIOD OF HIGHEST RX FREQUENCY BEGINS	JUN 1 OCT 1	JUL 1	MAY 1
(PERCENT PROBABILITY)	10%	56%	78%

Figure 6: RXBURN Seasonal Progression of Prescription Frequencies Format

PROGRAM RXBURN: RUN NO. 1 DISTRICT: FIRE LAB FOREST: MONTANA PAGE NO. 2

PRESCRIPTION OCCURRENCE BY 10 DAY PERIOD AND MONTH

			PREFERABLE DAYS			ACCEPTABLE DAYS			UNACCEPTABLE DAYS		
MONTH	PERIOD BEGINS	NO. DAYS	MEAN	NUMBER	PERCENT	MEAN	NUMBER	PERCENT	MEAN	NUMBER	PERCENT
MAY	1	102	0	4	4%	1	18	18%	5	80	78%
MAY	11	109	0	5	5%	2	32	30%	4	71	66%
MAY	21	118	1	8	7%	3	40	34%	4	70	59%
MAY	TOTAL	328	1	17	5%	6	90	27%	14	221	67%
JUN	1	106	1	11	10%	3	48	45%	3	47	44%
JUN	11	109	0	4	4%	2	39	36%	4	66	51%
JUN	21	106	0	6	6%	3	45	42%	3	55	52%
JUN	TOTAL	321	1	21	7%	8	132	41%	11	168	52%
JUL	1	135	0	3	2%	5	76	56%	4	56	41%
JUL	11	150	1	8	5%	4	62	41%	5	80	53%
JUL	21	165	0	5	3%	4	63	38%	6	97	59%
JUL	TOTAL	450	1	16	4%	13	201	45%	15	233	52%
AUG	1	159	0	7	4%	4	66	42%	5	86	54%
AUG	11	146	0	3	2%	4	56	38%	5	87	60%
AUG	21	159	1	10	6%	4	67	42%	5	82	52%
AUG	TOTAL	464	1	20	4%	12	189	41%	16	255	55%
SEP	1	136	1	12	9%	3	55	40%	4	69	51%
SEP	11	123	1	11	9%	3	42	34%	4	70	57%
SEP	21	116	1	11	9%	2	39	34%	4	66	57%
SEP	TOTAL	375	2	34	9%	9	136	36%	13	205	55%
OCT	1	90	1	9	10%	1	20	22%	4	61	68%
OCT	11	90	0	3	3%	1	21	23%	4	66	73%
OCT	21	79	0	0	0%	1	22	28%	4	56	72%
OCT	TOTAL	259	1	12	5%	4	63	24%	11	193	71%
NOV	TOTAL	0	0	0	0%	0	0	0%	0	0	0%
TOTAL	TOTAL	2196	8	120	5%	51	811	37%	79	1265	58%

Figure 7: RXBURN Prescription Run Length Format

PROGRAM RXBURN: RUN NO. 1 DISTRICT: FIRE LAB FOREST: MONTANA PAGE NO. 3

PRESCRIPTION RUN LENGTH SUMMARY

		PREFERABLE DAY RUNS				ACCEPTABLE DAY RUNS				UNACCEPTABLE DAY RUNS			
			PERCENTILES				PERCENTILES				PERCENTILES		
MONTH	PERIOD BEGINS	MEAN	25TH	MEDIAN	75TH	MEAN	25TH	MEDIAN	75TH	MEAN	25TH	MEDIAN	75TH
MAY	1	2	1	1	3	1	1	1	2	4	2	4	7
MAY	11	1	1	1	1	2	1	2	2	3	1	2	5
MAY	21	1	1	1	1	2	1	1	2	3	1	2	5
MAY	TOTAL	1	1	1	1	2	1	1	2	4	1	3	8
JUN	1	2	1	1	2	2	1	1	3	2	1	2	3
JUN	11	1	1	1	1	2	2	2	2	3	1	2	5
JUN	21	1	1	1	1	2	1	1	2	3	1	2	4
JUN	TOTAL	1	1	1	1	2	1	2	3	3	1	2	5
JUL	1	1	1	1	1	2	1	2	3	2	1	1	2
JUL	11	1	1	1	1	2	1	1	2	2	1	1	3
JUL	21	1	1	1	1	2	1	1	2	3	1	2	4
JUL	TOTAL	1	1	1	1	2	1	1	2	2	1	2	3
AUG	1	1	1	1	1	2	1	1	2	2	1	2	3
AUG	11	1	1	1	1	2	1	1	3	3	1	2	4
AUG	21	1	1	1	1	2	1	1	2	2	1	2	3
AUG	TOTAL	1	1	1	1	2	1	1	3	3	1	2	3
SEP	1	1	1	1	1	2	1	1	2	2	1	2	2
SEP	11	1	1	1	1	2	1	2	2	3	1	2	5
SEP	21	1	1	1	1	2	1	1	2	3	1	2	3
SEP	TOTAL	1	1	1	1	2	1	1	2	3	1	2	4
OCT	1	1	1	1	1	1	1	1	2	3	1	2	4
OCT	11	2	1	1	2	2	1	1	3	4	2	3	6
OCT	21	0	0	0	0	2	1	1	2	2	1	1	2
OCT	TOTAL	1	1	1	1	2	1	1	2	4	1	2	5
NOV	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0

Figure 8: RXBURN Prescription Persistence and Transition Probability Format

PROGRAM RXBURN: RUN NO. 1 DISTRICT: FIRE LAB FOREST: MONTANA PAGE NO. 4

PROBABILITY OF MEETING PRESCRIPTION 1, 2, AND 3 DAYS IN THE FUTURE

MONTH: MAY

TODAYS	*** TOMORROW ***			**** 2 DAYS ****			**** 3 DAYS ****				N DAYS
COND	PREF	ACCP	UNAC	PREF	ACCP	UNAC	PREF	ACCP	UNAC		
PREF	12%	53%	35%	9%	37%	54%	7%	32%	62%	PREF	17
ACCP	12%	46%	42%	8%	35%	57%	6%	31%	63%	ACCP	84
UNAC	2%	18%	80%	4%	24%	72%	5%	26%	69%	UNAC	215

MONTH: JUN

TODAYS	*** TOMORROW ***			**** 2 DAYS ****			**** 3 DAYS ****				N DAYS
COND	PREF	ACCP	UNAC	PREF	ACCP	UNAC	PREF	ACCP	UNAC		
PREF	20%	60%	20%	10%	51%	39%	8%	45%	47%	PREF	20
ACCP	9%	55%	35%	8%	46%	45%	7%	43%	50%	ACCP	130
UNAC	3%	28%	69%	5%	37%	53%	6%	40%	54%	UNAC	171

MONTH: JUL

TODAYS	*** TOMORROW ***			**** 2 DAYS ****			**** 3 DAYS ****				N DAYS
COND	PREF	ACCP	UNAC	PREF	ACCP	UNAC	PREF	ACCP	UNAC		
PREF	0%	75%	25%	4%	48%	43%	3%	45%	52%	PREF	15
ACCP	4%	51%	44%	3%	46%	51%	3%	44%	52%	ACCP	204
UNAC	3%	35%	62%	3%	42%	54%	3%	44%	53%	UNAC	225

What information is needed to use these programs ?

To use either of these programs data from the National Fire Weather Library (Furman and Brink, 1975) must be accessed. The process is completely defined in that publication and also summarized in this paper for user convenience. Use of these data impose several restrictions on results from the programs. As Gibson (1977) and others have noted, observations are taken only once per day over the length of the fire season. This season is rarely more than five months annually. The result is that a single observation must be considered representative of the entire day, when in fact it represents the 'typical worst' conditions. Secondly, data tend to be scarce during the pre- and post-fire season-- times when prescribed burning operations are generally most active.

Other information needed to use the programs are summarized in user information worksheets for RXWTHR and RXBURN (figures 9 and 10, respectively).

How should the programs be used ?

Ideally, the programs should be used sequentially. RWWTHR will give the manager a method for screening possible combinations of prescription factors to eliminate those which have a low probability of occurring simultaneously, as well as supplying a local fire climatological summary.

Once a feeling for the occurrence and timing of desired prescription conditions is reached, RXBURN may be used to provide a detailed summary of prescription occurrence frequencies for the actual planning process.

RXWTHR should only be run as few times as possble for any given station, while RXBURN may be run many times for different prescriptions and planning processes. Each program is, however, completely independent of the other and sequential use is not mandatory.

Figure 9: RXWTHR User information sheet

RXWTHR USER INFORMATION SHEET

TOTAL NUMBER OF STATIONS TO BE ANALYZED IN THIS RUN _____

USER: ____________________ DISTRICT: ______________ FOREST: ______________

ACTIVITY: ____

____

FIRE WEATHER STATION INFORMATION

NAME: ____________________ NUMBER: ________ ELEVATION (feet): ____________

LATITUDE: ____________ CLIMATE CLASS: ________ SLOPE CLASS: ____________

NFDRS FUEL MODEL: _____* LAST FROST: ________* YEAR BEGIN: ____________

YEAR END: ____________ DATE BEGIN: ________ DATE END: ____________

SITE ADJUSTMENT FACTORS (if any)

ASPECT: ______ SITE ELEVATION: __________ CANOPY COVER: ________

1 = north 2 = east
3 = south 4 = west

1 = open
2 = closed

DUFF/SOIL HORIZON INFORMATION (if DUFF MOISTURE selected) **

LAYER	DUFF/SOIL TYPE	THICKNESS
1.	__________	______
2.	__________	______
3.	__________	______
4.	__________	______
5.	__________	______

SUMMARY TABLE(S) REQUESTED (if any, select up to 15)

__ STATE OF THE WEATHER
__ TEMPERATURE (F)
__ RELATIVE HUMIDITY (%)
__ WIND DIRECTION (8 point)
__ WIND SPEED (mph)
__ MAX TEMPERATURE (24 hour)
__ MIN TEMPERATURE (24 hour)
__ MAX RELATIVE HUMIDITY (24 hour)
__ MIN RELATIVE HUMIDITY
__ PRECIP DURATION (in last 24 hours, hours)
__ PRECIP AMOUNT (24 hour; hundreths inches)
__ 1 HOUR FUEL MOISTURE (%)
__ 10 HOUR FUEL MOISTURE (%)
__ 1978 NFDRS ERC
__ 1978 NFDRS BI
__ DUFF MOISTURE (24 hour average, %)

CO-OCCURRENCE TABLE(S) REQUESTED (if any; for 2-way tables leave last space blank)

1. ____________________ with ____________________ with ____________________

2. ____________________ with ____________________ with ____________________

3. ____________________ with ____________________ with ____________________

4. ____________________ with ____________________ with ____________________

5. ____________________ with ____________________ with ____________________

* Needed only for computation of 1978 NFDRS indices.
** See Users' Guide for details.

Figure 10: RXBURN User information sheet

RXBURN USER INFORMATION SHEET

TOTAL NUMBER OF STATIONS TO BE ANALYZED IN THIS RUN ______

USER: ____________ DISTRICT: ____________ FOREST: ____________

ACTIVITY: ____

FIRE WEATHER STATION INFORMATION

NAME: ____________ NUMBER: ________ ELEVATION (feet): ________

LATITUDE: ________ CLIMATE CLASS: ________ SLOPE CLASS: ________

NFDRS FUEL MODEL: _____ * LAST FROST: ________ * YEAR BEGIN: ________

YEAR END: ________ DATE BEGIN: ________ DATE END: ________

SITE ADJUSTMENT FACTORS (if any)

ASPECT: ______ SITE ELEVATION: ________ CANOPY COVER: ______

1 = north 2 = east 1 = open
3 = south 4 = west 2 = closed

DUFF/SOIL HORIZON INFORMATION (if DUFF MOISTURE selected) **

LAYER	DUFF/SOIL TYPE	THICKNESS
1.	______	______
2.	______	______
3.	______	______
4.	______	______
5.	______	______

PRESCRIPTION FACTOR SELECTIONS (check and set limits for up to 15)

FACTOR	PREFERABLE RX MIMIMUM	PREFERABLE RX MAXIMUM	ACCEPTABLE RX MINIMIUM	ACCEPTABLE RX MAXIMUM
__ STATE OF THE WEATHER	____	____	____	____
__ TEMPERATURE (F)	____	____	____	____
__ RELATIVE HUMIDITY (%) . . .	____	____	____	____
__ WIND DIRECTION (8 point). . .	____	____	____	____
__ WIND SPEED (mph)	____	____	____	____
__ MAX TEMPERATURE (24 hour) . .	____	____	____	____
__ MIN TEMPERATURE (24 hour) . .	____	____	____	____
__ MAX RELATIVE HUMIDITY (24 hour) .	____	____	____	____
__ MIN RELATIVE HUMIDITY (24 hour)	____	____	____	____
__ DAYS SINCE LAST PRECIP . .	____	____	____	____
__ PRECIP AMOUNT (24 hour, in x 100)	____	____	____	____
__ 1 HOUR FUEL MOISTURE (%). . .	____	____	____	____
__ 10 HOUR FUEL MOISTURE (%). .	____	____	____	____
__ 1978 NFDRS ERC	____	____	____	____
__ 1978 NFDRS BI	____	____	____	____
__ DUFF MOISTURE (24 hour ave,±%)	____	____	____	____

* Needed only for computation of 1978 NFDRS Indices.

** See Users' Guide for details.

What are the options and features available in the programs ?

-- FORTRAN IV code is ASCII standard.

-- 1978 National Fire Danger Rating System (NFDRS) algorithms and subroutines are used by the programs where applicable (Deeming and others 1977).

-- The routines operate on simple input streams.

-- The programs contain input error checks that print error messages.

-- The programs offer 1978 NFDRS indices Energy Release Component (ERC) and Burning Index (BI) as presription parameters based on NFDRS fuel models.

-- The programs contain site adjustment factors to adjust fuel moisture values (and resulting ERC's and BI's) to locations with elevations, aspects, and canopy covers different than those of the user-specified station.

-- RXWTHR allows up to 15 summary tables and 5 co-occurrence tables to be produced in a single run.

-- RXBURN allows up to 15 prescription factors to be simultaneously considered in a prescription condition.

-- Up to 99 fire weather stations may be analysed for summaries or prescription occurrence in a single run.

-- Repeated runs of the same fire weather station allowing different prescription conditions to be analyzed in one run is possible through the construction of a disk file to hold first run computations.

-- A newly developed duff moisture model is available (Fosberg, 1975).

-- RXBURN allows two prescription condition ranges to be entered for each prescription factor. One is an ideal or 'preferable' burning condition, the other is an 'acceptable' buring condition.

-- RXWTHR allows the number of days since last precipitation as a prescription condition.

Creating a data file from the National Fire Weather Library

Full documentation is available from Furman and Brink, (1975) and is summarized sufficiently here for user convienience.

In obtaining data from the library, two items of information are needed. First is the six digit code (or codes) of the fire weather station(s) to be analyzed and the years of data to be analyzed. Second is the file name in the library that contains the lowest station code that will be used in the analysis. For example if the stations to be analyzed are 034567, 245789, and 003452, only the file name that contains station 003452 is needed.

Obtaining a file name.

There is a possibility that a local fire weather officer, fire management officer, or computer specialist would have a listing of the files in the library. If not, or if the list is not relatively current, obtain a file list in the following manner.

```
         1         2         3         4         5
12345678901234567890123456789012345678901234567890
@RUN......
@ASG, A FIREDATALIB*PROGRAMS.
@XQT FIREDATALIB*PROGRAMS.LISTFILES
@FIN
```

System software will then respond with a listing of file names and stations in the file. The general format follows. Note- ssssss is the six digit station code, and yy is the year that data begins (FROM) or ends (THROUGH); nn, mm, and oo are assorted numbers and letters of file names.

FILE NAME	STATION YEAR LIMITS FROM	THROUGH	DATE OF LAST UPDATE
FIREDATALIB*nn-mm	ssssssyy	ssssssyy	mmddyy
FIREDATALIB*oo	ssssssyy	ssssssyy	mmddyy
etc.			

Scan the station year limits column until the group containing the the lowest 6 digit station code of stations to be analyzed is found. The entire file name (FIREDATALIB*mm-nn) is to be used in place of "FILE" in the following data acquisition sequence.

Creating a card image file for use in RXWTHR and RXBURN

To create a card image file of fire weather data for use in RXBURN or RXWTHR, execute the following sequence on the FCCC UNIVAC computer. Note: Again, ssssss is the station six digit code, yy is the year to begin data file with and the second yy is the year to end the file with. If all available years are requested, use yy = 00, and yy = 99.

```
         1         2         3         4
1234567890123456789012345678901234567890
@RUN
@ASG, A FIREDATALIB*PROGRAMS.
@ASG, A "FILE".
@USE 2., "FILE".
@ASG,T 7.
@XQT FIREDATALIB*PROGRAMS.GETDATA2
  ssssssyy  ssssssyy
  etc., until all stations are listed in ASCENDING ORDER !!
@FREE 2.
```

System software will then respond with a list of the station numbers and years along with a tally of the total number of records in the newly created card image file. This file is now ready for analysis by programs RXWTHR or RXBURN. It is usually a very good idea to save the newly created file so that on subsequent runs of either program, the file will not have to be recreated.

PROGRAM USE AND DEMONSTRATION

USING PROGRAM RXWTHR

To use RXWTHR, four steps must be followed.

Step 1. Fill out user information sheet(s) (see figure 9)

One sheet should be completed for each station to be summarized, or for each summary for a station. The entries on the sheet are mostly self-explanatory, and are briefly summarized here for completeness.

a. Total number of stations in run

This value is the number of different stations that will have summaries produced in one run of RXWTHR.

b. Fuel model and date of last spring frost

These values need only be entered when NFDRS indices are requested in output tables. NFDRS fuel model descriptions are detailed in appendix A.

c. Slope class

This value must be entered if NFDRS incices or site adjustment options are selected. Slope classes are defined in appendix B.

d. NFDRS climate class

This value should be entered on all information sheets and are detailed in appendix C.

e. Activity information

User comments and documentation are entered here. Up to 80 characters are allowed. Suggested entries include, user name, project objectives, site adjustment factors, district information, etc.

f. Duff/soil horizon information

This information is only required with the selection of duff moisture as an output parameter. Instructions are detailed in appendix D.

g. Summary tables

If summary tables are desired, select parameters for inclusion.

h. Co-occurrence tables

If co-occurrence tables are desired, select up to 5 by filling the blanks with the desired parameters from the total list in the summary section. The only limitation is wind direction must be the first parameter entered in a table composition (See summary list, table 9).

Step 2. Create data file for program use and load program RXWTHR

File creation was previously covered; program loading is done by the execution of the following control cards.

```
         1         2         3
123456789012345678901234567890
@ASG, A R1LIB*PROGRAMS.
@XQT R1LIB*PROGRAMS.RXWTHR
```

Step 3. Transfer information from user sheet(s) to machine readable formats.

The information from each information sheet constitutes a directive block that instructs the program what options are requested and supplies other needed information. There must be one (1) directive block for each station in the analysis, and for each multiple run of a single station. Information entered in one directive block does not need repeating in subsequent station anlysis or multiple runs if the information does not change. Details of option and information entry are detailed below with examples.

a. Total Number of Stations card

This card must be the first in each directive block. The value is entered in columns 1 and 2, right justified, no decimal.

```
1234567890
nn
```

b. Station, years and dates of analysis cards

The first card in this sequence instructs the program that three cards of station, year and dates information follow. It consists of the word STATION beginning in the first column. The 1st trailing card contains complete station information as detailed in table 3. This is then followed by two more trailing cards with additionl information. The

Table 3: Station Information Card - Variables; Ranges; Formats; Information Sources.

	INPUT VARIABLE	LIMITS OF VALUE RANGES	CARD COLUMNS (INCLUSIVE)	FORMAT	SOURCE
1.	Station Name	15 Characters	1-15	3A5	user
2.	Station Number (6 digit)	0-999999	17-22	I6	user
3.	Station Elevation (feet)	0-99999	24-28	F5.0	user
4.	Station Latitude (degrees)	0-99	30-31	I2	user
5.	NFDRS Climate Class	1-4	33	I1	Appendix C
6.	NFDRS Slope Class	1-5	35	I1	Appendix B
7.	NFDRS Fuel Model	A-U (except M)	37	A1	Appendix A
8.	Date of Last Frost	0101-1231	39-42	I4	user
9.	Repeat Run ? (REPEAT)	T or blank	44	L1	user
10.	Save Run ? (SAVE)	T or blank	46	L1	user
11.	Site Adjustments ? (ADJUST)	T or blank	48	L1	user
12.	Site Aspect Code	1-4	50	I1	user
13.	Site Elevation (feet)	0-99999	52-56	F5.0	user
14.	Site Canopy Cover	1-2	58	I1	user

REPEAT, SAVE, AND ADJUST are logical variables.

If the run is to save computations for the next run to use, enter a T in column 46, otherwise leave column 46 blank.

If the run is to use computations from the last run, enter a T in column 44, otherwise leave column 44 blank.

If the run is to make site adjustments, enter a T in column 48. Be sure if site ajustments are to be made that correct values are entered for aspect, elevation, canopy, and NFDRS slope class.

If the run is not to make site adjustments, leave columns 48 through 58 blank.

first identifies the years to begin and end data inclusion to the analysis, the second identifies the seasonal dates of data inclusion. If all available years are desired, use 1900 to 1999. Program RXWTHR is restricted to five (5) months of data analysis in a single run. For stations with more than five months of archival data, see the options section (page 32). For an example, consider Philipsburg ranger station, for the seasonal dates of 1 June to 15 September for 1960 to 1977.

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
STATION
PHILIPSBURG RS  243002  5280 46 3 3 H 0615     T 3  6200 1
YEARS       1960  1977
DATES       0601  0915
```

c. Activity information card

The first card in this sequence instructs the program that one card of activity information follows. It consists of the word ACTIVITY beginning in column 1. It is followed by a card that contains the information under activity on the user information sheet.

```
         1         2         3         4         5         6         7 8
1234567890123456789012345678901234567890123456789012345678901234567890..0
ACTIVITY
  FIRE WEATHER SUMMARIES FOR PHILIPSBURG, SNAFU JONES, PROJECT 5
```

d. Duff/soil information

This input sequence begins with a card instructing the program how many layers (cards) of duff/soil information follow. It consists of the word DUFF in columns 1 through 4, and the total number of layers (2 to 5) in column 12. No decimal is punched. This card is then follow by up to 5 cards that define the layer type and thickness (in centimeters). Layer type is in columns 1 through 5, and thickness in columns 6 through 10. Both values have decimals punched.

```
         1         2
12345678901234567890
DUFF       3
 1.   3.5
 2.   7.0
 7. 300.0
```

e. Summary table option cards

This sequence begins with a card that instructs the program that summary table options follow. The word SUMMARY is printed beginning in column 1 and is followed by up to 15 cards defining the parameters to

be summarized. There is one card for each parameter checked on the sheet. The entire parameter name should be spelled correctly beginning in the 6th column of the card. Information in the parenthesis may be excluded. After the last option card has been printed, instruct the program that the last card has been read by placing the word END beginning in the 1st column of the next card.

```
         1         2         3
123456789012345678901234567890
SUMMARY
     TEMPERATURE
     WIND SPEED
END
```

f. Co-occurrence table option cards

This sequence begins by instructing the program that co-occurrence option cards follow. This is done by use of the word CO-OCCURR beginning in the 1st column. It is followed by up to 5 option cards that define what tables are to be produced. Values are transferred from the user sheet to cards, one card per table. Make sure the spelling is the same as the parameters in the summary list. The first parameter begins in the 6th column, the second in the 31st, and the third (if any) begins in the 56th column. Again information in the parenthesis should be excluded and the last option card is followed by an END card.

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
CO-OCCUR
     WIND DIRECTION           WIND SPEED
     TEMPERATURE              RELATIVE HUMIDITY        WINDSPEED
END
```

g. The RUN card

This card must be the last card in each directive block. It consists simply of the word RUN in columns 1 through 3 and signals that all cards in the block have been read. The program then begins execution.

```
1234567890
RUN
```

Step 4. Terminate program execution

The program will continue execution, reading one directive block at a time, and preforming the requested calculations until coming upon and end-of-file mark (@EOF) when reading the first card of the next directive block (Number of

Stations). After all directive blocks have been entered, the program is terminated by the following commands.

```
1234567890
@EOF
@FIN
```

RXWTHR DEMONSTRATION

Putting together steps 1 through 4 results in the execution of a very simple run of RXWTHR. For demonstration purposes, an example of analysis two stations in a single run will be used. Other runs are demonstrated in the Program Options section. In this example Philipsburg ranger station and West Glacier headquarters are the two stations in the sample. Assume data file is FIREDATALIB*12-13. Remember that stations must be analyzed in ascending order (the same order that they are retrieved from the data library).

Step 1. Fill out information sheets (see figures 11 and 12)

```
                  1         2         3         4         5         6        8
        123456789012345678901234567890123456789012345678901234567890123.....90
        @RUN,...,.....
        @ASG, A FIREDATALIB*PROGRAMS.
        @ASG, A FIREDATALIB*12-13.
        @USE 2., FIREDATALIB*12-13.
        @USE, T,7.
Step 2  @XQT FIREDATALIB*PROGRAMS.GETDATA2
          24020755  24020778
          24300260  24300277
        @FREE 2.
        @ASG, A  R1LIB*PROGRAMS.
        @XQT R1LIB*PROGRAMS.RXWTHR
        02
        STATION
         WEST GLACER      240207   3200 46 3
        YEARS      1955   1978
        DATES      0601   0915
        ACTIVITY
Step 3    BRIEF FIRE WEATHER SUMMARIES FOR WEST GLACIER HEADQUARTER, W. COLONY
        SUMMARY
             TEMPERATURE
             WIND DIRECTION
        END
```

```
          1         2         3         4         5         6         8
12345678901234567890123456789012345678901234567890123456789012345678901234.....0
CO-OCCUR
    WIND DIRECTION             WIND SPEED
    TEMPERATURE                RELATIVE HUMIDITY         WIND SPEED
END
RUN
02
```

Step 3 con't

```
STATION
PHILIPSBURG RS   243002   5280 46 3
YEARS        1960  1977
DATES        0501  0931
ACTIVITY
   DEMONSTRATION OF RXWTHR OUTPUT FOR PHILIPSBURG RANGER STATION
RUN
@EOF
```

Step 4

```
@FIN
```

RXWTHR OUTPUT - INTERPTATION

Identical output (format) would be produced by the above demonstration. For purposes of brevity, only output from the second station, Philipsburg will be discussed.

Summary Tables

Relative frequency of occurrence of selected class values, sample size, mean value, standard deviation, median value, and value ranges are tabulated for 10-day and monthly periods (see figure 1). For the parameters wind direction and state of the weather, the tables simply consist of relative frequency of occurrence of each singular class, and the most often occurring class. This format is displayed in figure 2.

Interpretation of these tables should be quite straightforward; they are simply summary tables of historical values. In both tables, cumulative frequencies may be computed by the addition of relative frequency values. For example, in May, (figure 1) 86.4% (41.5% + 16.2% + 15.9% + 12.8%) of the days in the sample had temperatures of less than 70 degrees. Similarly, only 13.6% of the temperature readings were 70 degrees or higher.

Figure 11: RXWTHR Information sheet for 1st station in demonstration

RXWTHR USER INFORMATION SHEET

TOTAL NUMBER OF STATIONS TO BE ANALYZED IN THIS RUN 2

USER: COLONY DISTRICT: GNP FOREST: MONTANA

ACTIVITY: Brief FIRE Weather Summaries for West Glacier Headquarters, W. COLONY

FIRE WEATHER STATION INFORMATION

NAME: West Glacier NUMBER: 240207 ELEVATION (feet): 3200

LATITUDE: 46° CLIMATE CLASS: 3 SLOPE CLASS: —

NFDRS FUEL MODEL: — * LAST FROST: — * YEAR BEGIN: 1955

YEAR END: 1978 DATE BEGIN: 0601 DATE END: 0915

SITE ADJUSTMENT FACTORS (if any)

ASPECT: — SITE ELEVATION: — CANOPY COVER: —

1 = north 2 = east 1 = open
3 = south 4 = west 2 = closed

DUFF/SOIL HORIZON INFORMATION (if DUFF MOISTURE selected) **

LAYER	DUFF/SOIL TYPE	THICKNESS
1.		
2.		
3.		
4.		
5.		

SUMMARY TABLE(S) REQUESTED (if any, select up to 15)

__ STATE OF THE WEATHER
X TEMPERATURE (F)
__ RELATIVE HUMIDITY (%)
X WIND DIRECTION (8 point)
__ WIND SPEED (mph)
__ MAX TEMPERATURE (24 hour)
__ MIN TEMPERATURE (24 hour)
__ MAX RELATIVE HUMIDITY (24 hour)
__ MIN RELATIVE HUMIDITY
__ PRECIP DURATION (in last 24 hours, hours)
__ PRECIP AMOUNT (24 hour; hundreths inches)
__ 1 HOUR FUEL MOISTURE (%)
__ 10 HOUR FUEL MOISTURE (%)
__ 1978 NFDRS ERC
__ 1978 NFDRS BI
__ DUFF MOISTURE (24 hour average, %)

CO-OCCURRENCE TABLE(S) REQUESTED (if any; for 2-way tables leave last space blank)

1. Wind Direction with Wind Speed with ____
2. Temperature with Relative Humid with WIND SPEED
3. ____ with ____ with ____
4. ____ with ____ with ____
5. ____ with ____ with ____

* Needed only for computation of 1978 NFDRS indices.
** See Users' Guide for details.

Figure 12: RXWTHR Information sheet for 2nd station in demonstration

RXWTHR USER INFORMATION SHEET

TOTAL NUMBER OF STATIONS TO BE ANALYZED IN THIS RUN 2

USER: BRADSHAW DISTRICT: FIRE LAB FOREST: MONTANA

ACTIVITY: Demonstration of RXWTHR OUTPUT for Philipsberg Ranger Station

FIRE WEATHER STATION INFORMATION

NAME: Philipsburg R.S. NUMBER: 243002 ELEVATION (feet): 5280

LATITUDE: 46 CLIMATE CLASS: 3 SLOPE CLASS: —

NFDRS FUEL MODEL: — * LAST FROST: — * YEAR BEGIN: 1960

YEAR END: 1977 DATE BEGIN: 0501 DATE END: 0931

SITE ADJUSTMENT FACTORS (if any)

ASPECT: ______ SITE ELEVATION: ______ CANOPY COVER: ______

1 = north 2 = east
3 = south 4 = west

1 = open
2 = closed

DUFF/SOIL HORIZON INFORMATION (if DUFF MOISTURE selected) **

LAYER	DUFF/SOIL TYPE	THICKNESS
1.		
2.		
3.		
4.		
5.		

SUMMARY TABLE(S) REQUESTED (if any, select up to 15)

- __ STATE OF THE WEATHER
- X TEMPERATURE (F)
- __ RELATIVE HUMIDITY (%)
- X WIND DIRECTION (8 point)
- __ WIND SPEED (mph)
- __ MAX TEMPERATURE (24 hour)
- __ MIN TEMPERATURE (24 hour)
- __ MAX RELATIVE HUMIDITY (24 hour)
- __ MIN RELATIVE HUMIDITY
- __ PRECIP DURATION (in last 24 hours, hours)
- __ PRECIP AMOUNT (24 hour; hundreths inches)
- __ 1 HOUR FUEL MOISTURE (%)
- __ 10 HOUR FUEL MOISTURE (%)
- __ 1978 NFDRS ERC
- __ 1978 NFDRS BI
- __ DUFF MOISTURE (24 hour average, %)

CO-OCCURRENCE TABLE(S) REQUESTED (if any; for 2-way tables leave last space blank)

1. WIND DIREC with WIND Speed with ______
2. Temp with Rel Hum with WIND Speed
3. ______ with ______ with ______
4. ______ with ______ with ______
5. ______ with ______ with ______

* Needed only for computation of 1978 NFDRS indices.

** See Users' Guide for details.

Co-occurrence tables -- 2-way

In the 2-way tables, two months of analysis are displayed on each page of output. One page (May and June) is exemplified in figure 3. Values within the tables are percent frequency of co-occurrence of selected class values of each parameter. In May, the most frequent co-occurrence condition is a wind speed of 3 to 5 mph from the southwest (9.8%). Most wind speed values were in the range of 3 to 8 mph as seen from the columnar frequency totals. This information should be used for general knowledge of an area's weather and to screen and identify periods that have high probabilities of meeting potential prescription conditions. After a prescription occurrence examination by RXBURN, this information could be used in making new prescriptions that have a high probability of occurring without having to quess.

Co-occurrence tables -- 3-way

One month of analysis is tabulated on each page of output for 3-way tables. Again, just one page is displayed in figure 4. The last parameter entered (wind speed in this case) is stratified into five value classes, the first two are stratified into 10 value classes. In this example, the frequency of co-occurrence of a wind speed from 6 to 11 mph, a temperature of 59 degress or less, and a relative humidity of 30-49% is 9.4%. It's obtained by adding the relative frequencies of all those particular stratifications. The number of days in the sample is given in the bottom right portion of the table. This information has the same potential uses as that from 2-way tables, with the added flexibility of the third parameter.

USING PROGRAM RXBURN

To use RXBURN, the same four steps required in RXWTHR are required with a slight variation in the substeps. The steps are listed again here with only the changes detailed. The structure of directive blocks is the same as RXWTHR; they must begin with the Number of Stations card and end with a RUN card.

Step 1. Fill out information sheets for RXBURN (figure 10)

All values up to prescription factor selections are identical to those in the RXWTHR sheet. A discussion on defining prescriptions for this section is given in appendix E.

Step 2. Create data file and load program RXBURN

This is done exactly the same as in RXWTHR except for the command @XQT R1LIB*PROGRAM.RXWTHR is altered to read:

@XQT R1LIB*PROGRAM.RXBURN

Step 3. Transfer information from users' sheet to machine readable formats

Items (a) through (d) are exactly the same as in RXWTHR. The changes in this step are outlined and exemplified here. 1/

e. User identification cards

RXBURN allows the information from the second line of the sheet to be entered to the program for documentation. The first card of this sequence instructs the program that the users' name, district, and forest follow on the next card. It consists of the word IDENTIFY beginning in the 1st column of the card. The information card follows with the users' name in columns 1 through 15, the district name in 21 through 35, and the forest name in 41 through the 55th column.

```
         1         2         3         4         5         6
123456789012345678901234567890123456789012345678901234567890
SEEMORE WOOD        CUT'N BURN          ANY-FOREST
```

1/ In RXBURN, there is no restriction on the number of months analyzed in one run.

f. Prescription condition cards

The first card of this sequence instructs the program how many prescription cards follow. The number (nn) may range from 1 to 15; the card consists of the word PRESCRIBE beginning in the first column, and the value nn in columns 11 and 12, right justified. This card is then followed by the prescription condition cards. These cards are transferred directly from the user information sheet. The parameter name begins in column 6, the preferable RX minimum values are entered in columns 33 through 35; preferable RX maximum values in columns 38 through 40; acceptable RX minimum values in columns 43 through 45; and acceptable maximum values in the 48th through 50th column. All values must be right justified. Values for wind direction should be entered as 8-points in a clockwise direction (e.g. SW to NW; NW to NE; E to W; etc.).

```
         1         2         3         4         5
12345678901234567890123456789012345678901234567890
PRESCRIBE 04
     WIND SPEED                    6    7    4   10
     TEMPERATURE                  58   59   55   63
     DAYS SINCE LAST PRECIP        7    7    4    9
     WIND DIRECTION               NW   NW    W    N
```

g. The RUN card

The RUN card serves the exact purpose of that in RXWTHR and must be the last card in each directive block.

Step 4. Terminate program execution

The program is terminated the same as RXWTHR.

In step 3, the order that items (b) through (f) are entered is not restricted as long as the order within each item is consistant with the directions as stated above. This is also true with input for RXWTHR.

RXBURN DEMONSTRATION

Again, combining steps 1 through 4 results in the execution of a simple run of RXBURN. In this demonstration, one station is used although more could be analyzed in a manner identical to that shown in RXWTHR. It is again assumed that the data resides on file FIREDATALIB*12-13.

Step 1. Fill out RXBURN information sheet (see figure 13).

```
                 1         2         3         4         5         6         8
        12345678901234567890123456789012345678901234567890123456789012345......0
        @RUN
        @ASG, A FIREDATALIB*PROGRAMS.
        @ASG, A FIREDATALIB*12-13.
        @USE 2., FIREDATALIB*12-13.
        @USE, T,7.
Step 2  @XQT FIREDATALIB*PROGRAMS.GETDATA2
          24300260  24300277
        @FREE 2.
        @ASG, A R1LIB*PROGRAMS.
        @XQT R1LIB*PROGRAMS.RXBURN
        01
        STATION
        PHILIPSBURG RS  234002  5280 46 3
        YEARS       1960  1977
        DATES       0510  1101
        ACTIVITY
Step 3     DEMONSTRATION OF RXBURN  OUTPUT FOR PHILIPSBURG RANGER STATION
        IDENTIFY
        LARRY BRADSHAW       FIRE LAB            MONTANA
        PRESCRIBE 03
             TEMPERATURE                 65   75   60   80
             RELATIVE HUMIDITY           20   30   20   55
             WIND SPEED                   4    9    0   15
        RUN
        @EOF
Step 4  @FIN
```

RXBURN OUTPUT - INTERPRETATION

Output from this demonstration is displayed in figures 5 though 8.

Summary page

Figure 5 exemplifies the format and values of the summary page of RXBURN output. Part 1 consists of input information: district name. user name, station information, sample size, and a prescription condition summary. Part 2 is composed of a prescription occurrence summary. It details the mean number of days per season of each prescription type, the frequency of occurrence for each type, and the highest 10-day period and month frequency of each prescription type. In this example, 8 days per year were preferable,

Figure 13: RXBURN Information sheet for demonstration

RXBURN USER INFORMATION SHEET

TOTAL NUMBER OF STATIONS TO BE ANALYZED IN THIS RUN 1

USER: LARRY BRADSHAW DISTRICT: FIRE LAB FOREST: MONTANA

ACTIVITY: Demonstration of RXBURN OUTPUT FOR Philipsberg Ranger Station

FIRE WEATHER STATION INFORMATION

NAME: Philipsberg NUMBER: 243002 ELEVATION (feet): 5280

LATITUDE: 46° CLIMATE CLASS: 3 SLOPE CLASS: —

NFDRS FUEL MODEL: — * LAST FROST: — * YEAR BEGIN: 1960

YEAR END: 1977 DATE BEGIN: 0501 DATE END: 1101

SITE ADJUSTMENT FACTORS (if any)

ASPECT: ______ SITE ELEVATION: ______ CANOPY COVER: ______

1 = north 2 = east
3 = south 4 = west

1 = open
2 = closed

DUFF/SOIL HORIZON INFORMATION (if DUFF MOISTURE selected) **

LAYER	DUFF/SOIL TYPE	THICKNESS
1.		
2.		
3.		
4.		
5.		

PRESCRIPTION FACTOR SELECTIONS (check and set limits for up to 15)

	FACTOR	PREFERABLE RX MIMIMUM	PREFERABLE RX MAXIMUM	ACCEPTABLE RX MINIMIUM	ACCEPTABLE RX MAXIMUM
__	STATE OF THE WEATHER				
X	TEMPERATURE (F)	65	75	60	80
X	RELATIVE HUMIDITY (%)	20	30	20	55
__	WIND DIRECTION (8 point). . .				
X	WIND SPEED (mph)	4	9	0	15
__	MAX TEMPERATURE (24 hour) . .				
__	MIN TEMPERATURE (24 hour) . .				
__	MAX RELATIVE HUMIDITY (24 hour) .				
__	MIN RELATIVE HUMIDITY (24 hour)				
__	DAYS SINCE LAST PRECIP . .				
__	PRECIP AMOUNT (24 hour, in x 100)				
__	1 HOUR FUEL MOISTURE (%). . .				
__	10 HOUR FUEL MOISTURE (%). .				
__	1978 NFDRS ERC				
__	1978 NFDRS BI				
__	DUFF MOISTURE (24 hour ave,%)				

* Needed only for computation of 1978 NFDRS indices.

** See Users' Guide for details.

51 were acceptable, and 79, or 58% of the season had unacceptable conditions. July had the highest acceptable prescription probability at 45%, and the highest 10-day period begins 1 July with a probability of 56%. Two ten day periods, June and October 1-10, had equal probabilities of preferable conditions with 10%, while the least likely period for a preferable or acceptable condition to occurr is the 10-day period beginning the 1st of May at 22% (100% - 78%).

Figure 6 shows the seasonal progress of prescription occurrences. The sample size, mean number of days, total count of occurrences, and occurrence frequency are given for each prescription type by 10-day, monthly, and seasonal stratifications. This information should be used to follow the historical pattern of prescription occurrences throughout the season. It may be helpful to plot the occurrence frequencies as they change over the season to obtain a better feel for the progression.

Figure 7 is an example of the output from the run length summary analysis of RXBURN. The mean run length (number of days in a row of the same prescription type), and the values at the 25th, 50th (median), and 75th percentile levels are given. Stratification is by 10-day and monthly periods. This information gives an indication of the length that favorable or unfavorable conditions tend to persist. In this demonstration, the period 1 July to 10 July averaged a preferable run length of 2 days. At the 25th percentile level the value was 1 day, 2 days was the median, and 3 days at the 75th percentile level. This means that there is a 50% chance of a preferable run length of at least 2 days, and 25% chance of one lasting at least 3 days.

The last section of output from RXBURN is the probability of a prescription type occurring in 1, 2, or 3 days, given an initial prescription type. Stratification is by month and three months are diplayed on each page of output. In this example, on a fair day in May, given an initial condition of preferable, there is a 12% chance the next day will be also, 9% for the second day, and 7% on the third. If the day were not so fair and conditions were unacceptable, the probabiltity that the next day would also be unacceptable is 80%, with only a 2% chance of it being acceptable.

SYSTEM OPTIONS

Analyzing More Than One Station

Up to 99 stations may be analyzed in a single execution of either RXWTHR or RXBURN by building station data files (stations in ascending order) and 'stacking' directive blocks (one for each station). This is illustrated in the RXWTHR demonstration (pp. 21-22, Step 3). Each directive block must begin with a Number of Stations card, and end with a RUN card. Information entered once within a directive block (e.g., prescription condition, summary table option, activity information, etc.) should not be re-entered in following blocks unless the information changes.

Stations With More Than 5 Months Weather Data

If two or more runs of RXWTHR are required to obtain a full season analysis, set the Number of Stations card value to one (01), and stack two (or three) directives blocks with the dates of analysis cards such that 5 months are analyzed in the first run. The dates of analysis cards in following directive blocks should have different seasonal dates such that the entire season is covered in two or three runs.

Multiple Prescription Condition Analysis of One Station

Primary use of this option is to analyze two or more prescription conditions for a single station in one program execution. It may also be used to get more that 5 co-occurrence tables in RXWTHR.

An initial run of the program stores computed and observed parameter values; subsequent runs access stored values, resulting in computer cost and time savings. Values are stored by entering a 'T' in column 46 of the first directive block's station information card.

SYSTEM OPTIONS

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If two or more runs of RXWTHR are required to obtain a full season analysis, set the Number of Stations card value to one (01), and stack two (or three) directives blocks with the dates of analysis cards such that 5 months are analyzed in the first run. The dates of analysis cards in following directive blocks should have different seasonal dates such that the entire season is covered in two or three runs.

Multiple Prescription Condition Analysis of One Station

Primary use of this option is to analyze two or more prescription conditions for a single station in one program execution. It may also be used to get more that 5 co-occurrence tables in RXWTHR.

An initial run of the program stores computed and observed parameter values; subsequent runs access stored values, resulting in computer cost and time savings. Values are stored by entering a 'T' in column 46 of the first directive block's station information card.

Stored computations are used by the entry of a 'T' in column 44 of the second directive block's, station information card (leave column 46 blank). The third and following directive blocks do not require that any of the station information series be entered. There must be one directive block for each prescription occurrence analysis. The following example shows how to analyze four prescription conditions at one station.

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
STATION    (Steps 1 and 2 are assumed completed)
01
 ANY STATION       123456   2345 45 3 3 H 0615    T
YEARS       1900   1999
DATES       0101   1215
ACTIVITY
    DEMONSTRATION OF MULTIPLE PRESCRIPTION ANALYSIS
IDENTIFY
WOODSY OWL             ICEBOX                 MONTANA
PRESCRIBE 01
     1978 NFDRS ERC                  2    4    1    10
RUN
01
STATION
 SAME STATION      123456   2345 45 3 3 H 0615 T
YEARS       1900   1999
DATES       0101   1215
PRESCRIBE 01
     1978 NFDRS ERC                  4    8    4    15
RUN
01
PRESCRIBE 01
     WIND SPEED                     13   18   10    20
RUN
01
PRESCRIBE 03
     WIND DIRECTION                  S    W     S  NW
     WIND SPEED                      4    8     2  12
     MAX TEMPERATURE                65   72    60  78
RUN
@EOF
@FIN
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
```

There is one restriction in using this option-- parameters not computed in the initial run cannot be used in subsequent prescription conditions. This applies only to NFDRS indices, fuel moisture, and duff moisture. Fuel moisture is computed when either fuel moisture or an NFDRS index is specified in a presscription. This also means that fuel models and site adjustments cannot be altered on subsequent runs.

Site adjustments

Site adjustment factor adjust fuel moisture values (and resulting NFDRS indices) to locations different from those of the base weather station. The adjustment factors are from research for Fire Behavior Officer training courses offered through the USDA Forest Service. Use is detailed on user information sheets and in table 13. A brief example follows of a station information card to adjust to a site 800 feet higher than a station, north aspect, closed canopy. It is assumed in this example that steps 1 and 2 have been completed.

```
         1         2         3         4         5         6         0
1234567890123456789012345678901234567890123456789012345678901234567890
 ANY STATION    123456  5000 3 3               T 1  5800 2
```

Note-- site elevations must be within 2000 feet of base station.

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APPENDIX A

NFDRS FUEL MODELS

FUEL MODEL A

This fuel model represents western grasslands vegetated by annual grasses and forbs. Brush or trees may be present but are very sparse, occupying less than one-third of the area. Examples of types where Fuel Model A should be used are cheatgrass and medusahead. Open pinyon-juniper, sagebrush-grass, and desert shrub associations may appropriately be assigned this fuel model if the woody plants meet the density criteria. The quantity and continuity of the ground fuels vary greatly with rainfall from year to year.

FUEL MODEL B

Mature, dense fields of brush 6 feet or more in height are represented by this fuel model. One-fourth or more of the aerial fuel in such stands is dead. Foliage burns readily. Model B fuels are potentially very dangerous, fostering intense, fast-spreading fires. This model is for California mixed chaparral generally 30 years or older. The F model is more appropriate for pure chamise stands. The B model may also be used for the New Jersey pine barrens.

FUEL MODEL C

Open pine stands typify Model C fuels. Perennial grasses and forbs are the primary ground fuel but there is enough needle litter and branchwood present to contribute significantly to the fuel loading. Some brush and shrubs may be present but they are of little consequence. Situations covered by Fuel Model C are open, longleaf, slash, ponderosa, Jeffrey, and sugar pine stands. Some pinyon-juniper stands may qualify.

FUEL MODEL D

This fuel model is specifically for the palmetto-gallberry understory-pine overstory association of the southeast coastal plains. It can also be used for the so-called "low pocosins" where Fuel Model O might be too severe. This model should only be used in the Southeast because of a high moisture of extinction.

FUEL MODEL E

Use this model after leaf fall for hardwood and mixed hardwood-conifer types where the hardwoods dominate. The fuel is primarily hardwood leaf litter. The oak-hickory types are best represented by Fuel Model E, but E is an acceptable choice for northern hardwoods and mixed forests of the Southeast. In high winds, the fire danger may be underrated because rolling and blowing leaves are not accounted for. In the summer after the trees have leafed out, Fuel Model E should be replaced by Fuel Model R.

FUEL MODEL F

Fuel Model F is the only one of the 1972 NFDRS Fuel Models whose application has changed. Model F now represents mature closed chamise stands and oakbrush fields of Arizona, Utah, and Colorado. It also applies to young, closed stands and mature, open stands of California mixed chaparral. Open stands of pinyon-juniper are represented; however, fire activity will be overrated at low windspeeds and where there is sparse ground fuels.

FUEL MODEL G

Fuel Model G is used for dense conifer stands where there is a heavy accumulation of litter and downed woody material. Such stands are typically overmature and may also be suffering insect, disease, wind, or ice damage--natural events that create a very

heavy buildup of dead material on the forest floor. The duff and litter are deep and much of the woody material is more than 3 inches in diameter. The undergrowth is variable, but shrubs are usually restricted to openings. Types meant to be represented by Fuel Model G are hemlock-Sitka spruce, Coast Douglas-fir, and windthrown or bug-killed stands of lodgepole pine and spruce.

FUEL MODEL H

The short-needled conifers (white pines, spruces, larches, and firs) are represented by Fuel Model H. In contrast to Model G fuels, Fuel Model H describes a healthy stand with sparse undergrowth and a thin layer of ground fuels. Fires in H fuels are typically slow spreading and are dangerous only in scattered areas where the downed woody material is concentrated.

FUEL MODEL I

Fuel Model I was designed for clearcut conifer slash where the total loading of materials less than 6 inches in diameter exceeds 25 tons/acre. After settling and the fines (needles and twigs) fall from the branches, Fuel Model I will overrate the fire potential. For lighter loadings of clearcut conifer slash, use Fuel Model J, and for light thinnings and partial cuts where the slash is scattered under a residual overstory, use Fuel Model K.

FUEL MODEL J

This model complements Fuel Model I. It is for clearcuts and heavily thinned conifer stands where the total loading of materials less than 6 inches in diameter is less than 25 tons/acre. Again, as the slash ages, the fire potential will be overrated.

FUEL MODEL K

Slash fuels from light thinnings and partial cuts in conifer stands are represented by Fuel Model K. Typically the slash is scattered about under an open overstory. This model applies to hardwood slash and to southern pine clearcuts where the loading of all fuels is less than 15 tons/acre.

FUEL MODEL L

This fuel model is meant to represent western grasslands vegetated by perennial grasses. The principal species are coarser and the loadings heavier than those in Model A fuels. Otherwise the situations are very similar; shrubs and trees occupy less than one-third of the area. The quantity of fuel in these areas is more stable from year to year. In sagebrush areas Fuel Model T may be more appropriate.

FUEL MODEL N

This fuel model was constructed specifically for the sawgrass prairies of south Florida. It may be useful in other marsh situations where the fuel is coarse and reedlike. This model assumes that one-third of the aerial portion of the plants is dead. Fast-spreading, intense fires can occur even over standing water.

FUEL MODEL O

The O fuel model applies to dense, brushlike fuels of the Southeast. O fuels, except for a deep litter layer, are almost entirely living in contrast to B fuels. The foliage burns readily except during the active growing season. The plants are typically over 6 feet tall and are often found under an open stand of pine. The high

pocosins of the Virginia, North and South Carolina coasts are the ideal of Fuel Model O. If the plants do not meet the 6-foot criteria in those areas, Fuel Model D should be used.

FUEL MODEL P

Closed, thrifty stands of long-needled southern pines are characteristic of P fuels. A 2- to 4-inch layer of lightly compacted needle litter is the primary fuel. Some small diameter branchwood is present but the density of the canopy precludes more than a scattering of shrubs and grass. Fuel Model P. has the high moisture of extinction characteristic of the Southeast. The corresponding model for other long-needled pines is U.

FUEL MODEL Q

Upland Alaskan black spruce is represented by Fuel Model Q. The stands are dense but have frequent openings filled with usually inflammable shrub species. The forest floor is a deep layer of moss and lichens, but there is some needle litter and small-diameter branchwood. The branches are persistent on the trees, and ground fires easily reach into the tree crowns. This fuel model may be useful for jack pine stands in the Lake States. Ground fires are typically slow spreading, but a dangerous crowning potential exists. Users should be alert to such events and note those levels of SC and BI when crowning occurs.

FUEL MODEL R

This fuel model represents the hardwood areas after the canopies leaf out in the spring. It is provided as the off-season substitute for E. It should be used during the summer in all hardwood and mixed conifer-hardwood stands where more than half of the overstory is deciduous.

FUEL MODEL S

Alaskan or alpine tundra on relatively well-drained sites is the S fuel. Grass and low shrubs are often present, but the principal fuel is a deep layer of lichens and moss. Fires in these fuels are not fast spreading or intense, but are difficult to extinguish.

FUEL MODEL T

The bothersome sagebrush-grass types of the Great Basin and the Intermountain West are characteristic of T fuels. The shrubs burn easily and are not dense enough to shade out grass and other herbaceous plants. The shrubs must occupy at least one-third of the site or the A or L fuel models should be used. Fuel Model T might be used for immature scrub oak and desert shrub associations in the West, and the scrub oak-wire grass type in the Southeast.

FUEL MODEL U

Closed stands of western long-needled pines are covered by this model. The ground fuels are primarily litter and small branchwood. Grass and shrubs are precluded by the dense canopy but occur in the occasional natural opening. Fuel Model U should be used for ponderosa, Jeffrey, sugar pine, and red pine stands of the Lake States. Fuel Model P is the corresponding model for southern pine plantations.

APPENDIX B

NFDRS SLOPE CLASS

DEFINITIONS

SLOPE CLASS	SLOPE (percent)
1	0-25
2	26-40
3	41-55
4	56-75
5	75 and above

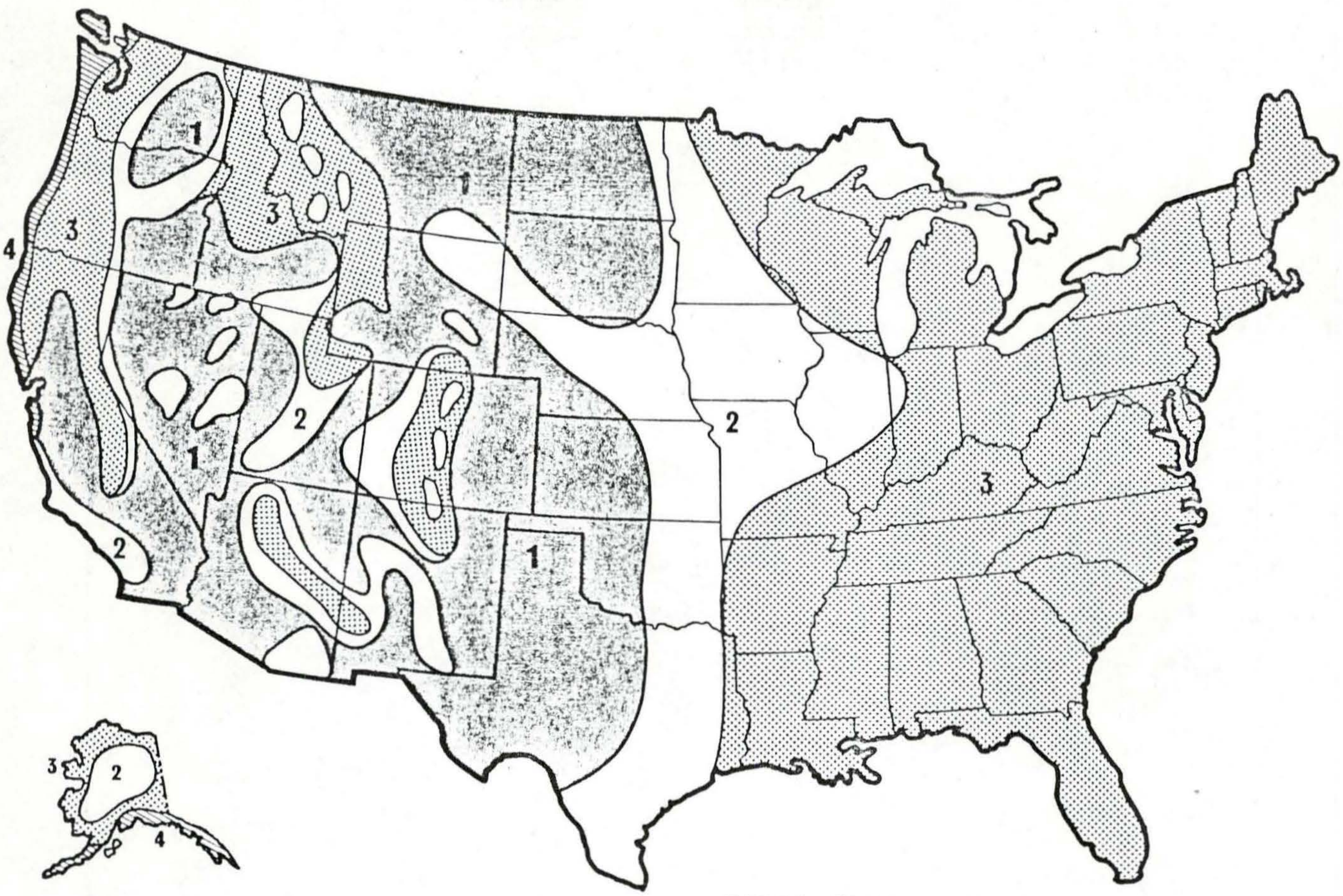
APPENDIX C

NFDRS CLIMATE CLASS

DEFINITIONS

NFDRS climate class	Thornthwaite[1] humidity province	Characteristic vegetation	Regions
1	Arid	Desert (sparse grass and scattered shrubs)	Sonoran deserts of west Texas, New Mexico, southwest Arizona, southern Nevada, and western Utah; and the Mojave Desert of California.
1	Semiarid	Steppe (short grass and shrubs)	The short grass prairies of the Great Plains; the sagebrush steppes and pinyon/juniper woodlands of Wyoming, Montana, Idaho, Colorado, Utah, Arizona, Washington, and Oregon; and the grass steppes of the central valley of California.
2	Subhumid (rainfall deficient in summer	Savanna (grasslands, dense brush and open conifer forests)	The Alaskan interior; the chaparral of Colorado, Arizona, New Mexico, the Sierra Nevada foothills, and southern California; oak woodland of California; ponderosa pine woodlands of the West; and mountain valleys (or parks) of the Northern and Central Rockies.
3	Subhumid (rainfall adequate in all seasons)	Savanna (grasslands and open hardwood forests)	Blue stem prairies and blue stem-oak-hickory savanna of Iowa, Missouri, and Illinois.
3	Humid	Forests	Almost the entire eastern United States; and those higher elevations in the West that support dense forests.
4	Wet	Rain forest (redwoods, and spruce-cedar-hemlock)	Coast of northern California, Oregon, Washington, and southeast Alaska.

[1]Thornthwaite 1931.



NFDRS CLIMATE CLASS

1
2
3
4

APPENDIX D

DUFF/SOIL HORIZON STRUCTURE

DUFF MOISTURE - Duff/soil horizon definitions.

Programs RXWTHR and RXBURN offer a newly applied duff moisture model. It must be stressed that the model is theoretical and has not been validated by field tests. It is based upon theorectical properties of water vapor transport through porus mediums. The model was developed by Michael Fosberg (Fosberg, 1975) and adapted for compter usage on archival fire weather data by Systems for Environmetal Management. It is offered strictly on an experimental basis in the present versions of RXWTHR and RXBURN. Further work and field testing is planned for the summer of 1979; resulting changes and calibrations will be incorporated into updated versions of the programs in late 1979. Any comments on model performance would be greatly appreciated.

To employ this option of programs RXWTHR and RXBURN, the user needs to provide information about the structure of forest floor. The floor must be broken into layers of homogenious materials: duff, humus, and a boundary or stable layer. At the surface, the boundary layer is the air, at the bottom, the layer is considered to be a sand. The user must specify the type of material of each layer and the thickness of each layer. Table 1 displays the types of materials that the model will presently accept and the appropiate codes to be entered in the duff information cards. The thickness of each layer is to be entered by the user in centimeters. At this time the bottom boundary layer is assumed to be sand with a thickness from 100 to 300 centimeters. This information still must be entered. The type entered for each layer is then used to calculate layer timelags based on physical properties of each of the layers.

Table 1: Duff/soil Type Codes

Duff/Soil Type	Code
Lodgepole Pine Duff	1.
Lodgepole Pine Humus	2.
Ponderosa Pine Duff	3.
Ponderosa Pine Humus	4.
Douglas-fir Duff	5.
Douglas-fir Humus	6.
Sand	7.

APPENDIX E

DEFINING PRESCRIPTIONS

DEFINING PRESCRIPTION CONDITIONS

RXBURN offers the unique feature of allowing two value ranges to be entered for each prescription factor in a prescription. They are defined as 'preferable' and 'acceptable' buring conditions. Preferable conditions are those ideal for meeting burning objectives. Acceptable conditions are broader (and more often occurring) ranges of values that will still meet burning objectives, though not as surely as buring in preferable conditions. All values outside the range of acceptable conditions are considered unacceptable.

As an example, a manager might plan to burn with a prescription that included a temperature of 58 or 59 degrees, last precipitation 7 days ago, and wind out of the northwest at 6 or 7 miles per hour. Realizing this tight prescription may have a limited chance of occurring, they consult climatological summaries from RXWTHR and decide on an acceptable prescription that will probably still meet burning objectives, and yet have a reasonable probability of occurring. The acceptable prescription might then enclude a temperature of 55 to 63 degrees, last precipitation 4 to 9 days ago, and a wind speed of 4 to 10 miles per hour from the west to north. In terms of input to RXBURN, this prescription would look like this.

FACTOR	PREFERABLE RX minimum	PREFERABLE RX maximum	ACCEPTABLE RX minimum	ACCEPTABLE RX maximum
Temperature	58	59	55	63
Days Since Last Precip	7	7	4	9
Wind Speed	6	7	4	10
Wind Direction	NW	NW	W	N

Any values outside the acceptable ranges would consitute an unacceptalbe burning condition. Note that wind direction limits must be entered in a clockwise manner.

SECTION 3

Program RXWTHR and Program RXBURN

DOCUMENTATION

TABLE OF CONTENTS

PREFACE TO SECTION 3

Section 3 contains documentation of all routines and functions of programs RXWTHR and RXBURN. It is intended to serve as a reference for programmers and users interested in the logic and structure of the programs. It provides variable identification of values stored in COMMON BLOCKS.

Part 1 of section 3 is a general overview of the structure of RXWHTR, and part 2 of this section provides documentation of the program. Part 3 of section 3 gives a general overview of program RXBURN, and part 4 documents the details of RXBURN that differ from those in RXWTHR.

PART 1

GENERAL OVERVIEW OF RXWTHR

Program RXWTHR computes summary tables and co-occurrence tables of user-selected fire weather parameters. All user input is read from device 5 in subroutine SETUP. All weather data from the National Fire Weather Library is read in subroutine CMPUTE from device 7. Based on user options, the program will calculate either summary tables or co-occurrence tables, or both. In each run of RXWTHR a maximum of 15 summary tables and 5 co-occurrence tables can be computed.

The general flow of the program is as follows:

Step 1: Read number of stations to be analzed in mainline control program RXWTHR.

Step 2: RXWTHR calls SETUP which reads user control sequence. SETUP then calls INTERP to interpret user input, set programs control variables and computation levels. INTERP then returns to SETUP which then calculates adjustment codes if needed and returns to RXWTHR.

Step 3: RXWTHR then calls CMPUTE. CMPUTE sets initial values and begins reading weather data and computing needed values as per user specification, and summarizes data by calling SUM.

Step 4: After all data has been read and values accumulated in SUM, CMPUTE calculates final statistics and outputs tables through 2 subroutines. RITE1 outputs the summary tables, RITE2 outputs the co-occurrence tables.

Step 5: After first station has been analyzed and queued to output, CMPUTE returns to RXWTHR to check for another station to analyze. If there are none, program terminates normally. If there is another station, general flow starts at Step 2 again until all stations have been analyzed.

In the following pages, the COMMON BLOCKS used by RXWTHR are first defined, and then mainline program RXWTHR is documented, then all other routines and functions are documented in alphabetical order.

PROGRAM RXWTHR

Narrative: Program RXWTHR is the mainline control program for the computation of climatological summary and co-occurrence tables. It keeps track of the number of stations to be analyzed and the number that have been analyzed. It resets the program or terminates it according to the number of stations requested.

The logic is:

Step 1: Set run number to zero.
Step 2: Read number of stations to be analyzed.
Step 3: If at eof, terminate run normally. If not, continue to step 4.
Step 4: Call SETUP
Step 5: Call CMPUTE
Step 6: Rewind disk file created by SAVE option (if used) and add 1 to the run number.
Step 7: Check to see if last station has been analyzed. If not, return to step 2. If so, rewind weather data file, set run number to zero again, and return to step 2 to see if stations are to be reanalzed with perhaps different fuel models, slope classes, or co-occurrence tables.

COMMON BLOCKS USED: NONE

A listing of all SUBROUTINES and FUNCTIONS that compose the body RXWTHR now follows. They are listed in alphabetical order and follow the same format as the mainline program documentation of RXWTHR.

PART 2

Program RXWTHR uses 9 labeled COMMON BLOCKS and no unlabeled COMMON BLOCKS. These are defined as follows.

COMMON /FIRE/ : Contains parameters used in system fire model routine.

VALUES SET : Values in /FIRE/ are set in subroutine FUELS and subroutine CURING, all variables are REAL.

VARIABLE		DESCRIPTION
W1D	:	weight of dead and down 1 hour fuels (lbs/ft^2)
W10D	:	" 10 hour fuels
W100D	:	" 100 hour fuels
W1000D	:	" 1000 hour fuels
W1DP	:	" 1 hour fuels + cured green fuels
IG	:	indicates first call to subroutine ERCSC
DEPTH	:	depth of fuel bed (inches)
HD	:	height of dead fuels (inches)
HL	:	height of live fuels "
MCWOOD	:	moisture content of woody fuels %
MHERB	:	moisture content of herbs %
SGHERB	:	surface area to volume ratio herbacious fuels
SGWOOD	:	" woody fuels
SG100D	:	" 100 hour dead and down
SIG1D	:	" 1 hour dead and down
SIG10D	:	" 10 hour dead and down
S1000D	:	" 1000 dead and down
WHERB	:	weight herbacious material
WHERBC	:	weight of cured herbacious material
WNDFC	:	wind factor
WWOOD	:	weight of woody fuels
MXD	:	moisture of extinction of dead and down fuels %
MHERBC	:	moisture content of cured herbacious material %

COMMON /LABELS/ : Contains Alphanumeric labels for output. All variables are integer and set in BLOCK DATA ALL.

ARRAY		DESCRIPTION
LBL1(4,17)	:	header labels for all parameters
LBL2(9)	:	header labels for wind direction
LBL3(10)	:	table labels for summary tables
LBL4(17)	:	units labels for all parameters
LBL5(17)	:	short header labels for co-occurrence tables
MUNTH(12)	:	month labels(JAN - DEC)

COMMON /LIM/	:	contains class level limits for all parameters. All values in /LIM/ are integer and are set in BLOCK DATA ALL except for LOW, which is set in the output routines.

ARRAY	:	DESCRITPION
LIMIT(9,17)	:	contains class value limits for all parameters except for STATE OF THE WEATHER.
LIMSW(10)	:	contains class value limits for STATE OF THE WEATHER
LOW(9)	:	contains lower class limits for output tables.

COMMON /OBSERV/	:	contains values from weather observation, computed moisture values, and other values needed for computation,

ARRAYS	:	DESCRIPTION
IOB(22)	:	Contains weather observation, plus computed values.
IOB(1)	;	station number
IOB(2)	:	year
IOB(3)	:	month
IOB(4)	:	day
IOB(5)	:	state of the weather
IOB(6)	:	temperature
IOB(7)	:	relative humidity
IOB(8)	:	duff moisture (computed)
IOB(9)	:	wind direction
IOB(10)	:	wind speed
IOB(11)	:	stick moisture (observed)
IOB(12)	:	maximum temperature
IOB(13)	:	mimimim temperature
IOB(14)	:	maximum relative humidity
IOB(15)	:	minimum relative humidtiy
IOB(16)	:	precipitation duration
IOB(17)	:	precipitation amount
IOB(18)	:	moisture index (1,2,or3)
IOB(19)	:	1 hour fuel moisture (computed)
IOB(20)	:	10 hour fuel moisture (computed or observed)
IOB(21)	:	1978 NFDRS ERC (computed)
IOB(22)	:	1978 NFDRS BI (computed)
STRUC(5,9)	:	contains duff/soil horizon structure information as input from SETUP. There are up to 5 horizons.
STRUC(I,1)	:	soil or duff type code
" 2	:	thickness of layer (cm)
" 3	:	particle temperature time-lag (seconds)
" 4	:	particle moisture time-lag (seconds)
" 5	:	bulk density layer (gm/cm^3)
" 6	:	particle density (gm/cm^3)
" 7	:	hydraulic conductivity (cm/sec)
" 8	:	moisture coefficient (dimensionless)
" 9	:	temperature coefficient (dimensionless)

VARIABLES	:	DESCRIPTION
MC1	:	moisture content of 1 hour fuels (REAL)
MC10	:	" " 10 hour fuels "
MC100	:	" 100 hour " "
MC1000	:	" 1000 hour " "
YMC10	:	yesterday's 10 hour fuel moisture
YMC100	:	" 100 " " "
IOPTIN	:	data processing option
TPTAMT	:	total precip amount (REAL)
ICLIM	:	climate class
ISLOPE	:	slope class
MOD	:	fuel model
LFROST	:	date of last spring frost (mmdd)
NSLABS	:	number of horizons in duff structure

COMMON /OPSET/ : contains program options as set in SETUP and INTERP.

ARRAYS	:	DESCRIPTION
KOPT(5,3)	:	5 = max table number, 3 = 3 - way co-occurrence table contains co-occurrence option order numbers.
L4(22)	:	contains number of class intervals for each parameters of IOB(22). Set in BLOCK DATA ALL.
INDEX(17)	:	contains array pointer elements that single which element of IOB(22) corresponds to a given summary or co-occurrence table. Set in BLOCK DATA ALL.
MEANOP(15)	:	contains summary table option numbers as set from INDEX
OPTION(5,3)	:	contains co-occurrence table option numbers as set from INDEX (integer)
NOPT(15)	:	contains option order numbers of summary tables

VARIABLES	:	DESCRIPTION
L	:	Program computation level (0 to 3)
NMEANS	:	number of summary tables requested (0 to 15)
NMONTH	:	number of months of data requested (1 to 5)
NTABLE	:	number of co-occurrence tables requested (0 to 5)

COMMON /SET/ : Contains run processing information as input in SETUP.

ARRAYS	:	DESCRITPION
ACT(16)	:	alphanumeric activity header information (16A5)
NAMSTA(3)	:	alphanumeric name up to 15 characters of station name

VARIABLES	:	DESCRIPTION
ADJUST	:	logical variable defining adjustment option specification
IASP	:	adjustment aspect code (1 to 4)
ICOV	:	adjustment cover code (1 to 2)

IELV	:	adjustment elevation code (1 - 3)
IDUFF	:	duff moisture option specification (0 = no, 1 = yes)
IDAYB	:	day to begin sample inclusion
IDAYE	:	day to end sample inclusion
ISLO	:	adjustment slope code (1 or 2)
IYEARB	:	year to begin sample
IYEARE	:	year to end sample
ELEV	:	station elevation
LAT	:	station latitude (I2)
MONTHB	:	month to begin sample
MONTHE	:	month to end sample
REPEAT	:	logical (L1) variable that specifies if run is to read from disk file created by SAVE option.
SAVE	:	logical (L1) variable that specifies if disk file is to be created for subsequent REPEAT runs.
NUMSTA	:	6 digit station identifier code

COMMON /STATS/ : contains statistical summary values for summary and co-occurrence tables. Arrays for use in summary tables are stratified by month(5); 10-day period of month(3); and summary table number(15). Arrays for co-occurrence are stratified by table number(5); month(5); 1st order class number(10), 2nd order class number(10), and 3rd order class number(5) transformed into a vector.

ARRAY	:	DESCRIPTION
MEAN(5,3,15)	:	accumulates values stratified as described above for summary tables.
SD(5,3,15)	:	accumulates sums of squares and then computed values of standard deviations are entered, stratified as described above.
IXTREM(5,3,15)	:	holds maximum values of parameters for use in range display in summary tables.
IXYEAR(5,3,15)	:	holds mimimum values of parameters for use in range display in summary tables.
MEDIAN(2250)	:	holds values ordered by class for computation of median values for display of summary tables. Values are stratified by period of month(3), month(5), summary table number(15), and class interval number(12), transformed into a vector.
CUMCO(12500)	:	cumulator array for co-occurrence tables, stratified as described above.
COUNT(5,3)	:	holds sample size stratified by month and period of month.

COMMON /BLOCK1/ : contains parameters used in duff moisture calculations, stratified by layer (1 to 5)

ARRAYS	:	DESCRIPTION
TEMP(5)	:	temperature of horizon (degrees K)
HUMID(5)	:	humidity of horizon %
DEPTH(5)	:	depth of layer from surface (cm)
ESAT(5)	:	saturation vapor pressure in horizon void space (dynes/cm^3)
EPRES(5)	:	vapor pressure in horizon void space (dynes/cm^3)
RHO(5)	:	density of void space in horizon layer (gm/cm^3)

VARIABLES	:	DESCRIPTION
TEMPIN	:	surface temperature (degrees K) - initial
HUMIN	:	initial suface relative humidity (%)
RV	:	gas constant (vapor) cgs units

COMMON /BLOCK2/ : contains parameters used for simulation and calculations of duff moisture values for case of rain, stratified by layer (1 to 5)

ARRAYS	:	DESCRIPTION
HYDROE(5)	:	effective hydraulic conductivity as affected by moisture stress, layer thickness, and porostiy (cm/sec)
PERC(5)	:	amount of actual water perculating through horizon layer (cm/sec)
PHI(5)	:	porostiy of horizon layer (dimensionless)
THETA(5)	:	volumetric water content of horizon layer due to free water from perculation rate.
DMC(5)	:	duff moisture content of horizon layer %
DTHETA(5)	:	portion of THETA in void lost or gained by adsorption or desorption of free water to particles in horizon layer.
SWITCH(5)	:	logical switch that specifies if horizon layer is to simulated at above FIBSAT values, or below FIBSAT values.
EMC(5)	:	moisture content of particles in horizon layer.
DELTAM(5)	:	change in water mass in void due to DTHETA and bulk density of layer.

VARIABLES	:	DESCRIPTION
DELTM	:	simulation time increment (2 hours = 7200 seconds)
PPTR	:	precipitation rate (cm/sec)
RHOW	:	density of water (= 1)
FIBSAT	:	particle saturation point (approx 28%)

SUBROUTINE ADSORP(I)

Narrative: Subroutine ADSORP is used in duff moisture calulations during periods that experienced rainfall. ADSORP is called by PERCOL, which was called by DUFF, which was called by CMPUTE. The parameter I is passed into ADSORP and is the current layer in the duff horizon that is being simulated.

COMMON BLOCKS used : /BLOCK2/, /OBSERV/

The logic is:

Step 1: Solve for effective perculation rate PPP, and then set QQQ and RRR from it.
Step 2: Call ROOT-- ROOT returns value for THETA after solving a 3rd degree polynomial equation.
Step 3: Compute particle moisture content adsorption rate (% MC/sec)
Step 4: Compute actual moiture content change (amount = rate x time)
Step 5: Adjust THETA (volumetric content of voids) by amount adsorped by particles.
Step 6: Calculate effective hydraulic conductivity due to water adsorption.
Step 7: Return to PERCOL

SUBROUTINE ALPHA(RF,AF)

Narrative: Subroutine ALPHA is passed the array RF, an array containing real values. It ENCODES the values and if the value is zero, sets it equal to an alpha blank in an A5 format. This makes all output of relative frequency values alpha, for easier readability. AF is the array that is passed back for output. ALPHA is called by RITE1, and uses no COMMON BLOCKS.

BLOCK DATA ALL

Narrative: Routine BLOCK DATA ALL sets data constants for all LABELED COMMON BLOCKS that are given values through the use of DATA statements.

COMMON BLOCKS USED: /OPSET/, /LABELS/, /LIM/

FUNCTION CALV(F)

Narrative: This real function coverts temperature in degrees F to temperature in degrees Kalvin and returns to calling program. CALV is a function from the NFDRS.

SUBROUTINE CMPUTE

Narrative: This routine is the major computation section of the program. It reads the weather data, and calls all other subroutines in the process. It computes statistical summaries and directs output procedures by calling output routines at appropriate places in the flow.

COMMON BLOCKS USED: /SET/, /OBSERV/, /STATS/, /OPSET/, /LABELS/, /FIRE/, /LIM/

The logic is:

Step 1: Initialize all constants, including site adjustment factors (IADJUS), zero out all values in COMMON BLOCK /STATS/.

Step 2: If fuel model is needed as per computation level (L), match the fuel model that was requested (MOD) with the test array of (MOD1) and get fuel bed parameters by calling FUEL(II). Then set the day of last frost (LFROST) to a month and day value for use in subroutine CURING.

STEP 3: Compute fire weather station pressure, adding 200 feet to the station elevation if Alaskan.

Step 4: Begin DO LOOP of reading weather data from 'tape 15'.

Step 5: If REPEAT run, skip calculations and read values from disk file, otherwise, make checks for correct station and if the day just read is within the time period requested.
If max/min values are requested for analysis, but missing from data record, read another record (Step 4).

Step 6: Determine if a new season has started. A new season is considered to have started if the year changes or there is a 30 day break in the records. If new season, set the logical varialbe INIT to .TRUE. This allows for initial values to be set.

Step 7: Call processing option setting routine OPTFIX.

Step 8: Call data testing routine TESTWX.
If there is an error in the data, write a message and read next record.

Step 9: If DUFF MOISTURE is requested, CALL DUFF(INIT,IFIRST)

Step 10: If no fuel moistures or NFDRS indices are requested, go to step 20.

Step 11: Compute solar declination by calling function DECL and passing month and day.

Step 12: Get 1 and 10 hour fuel moistures from subroutine ONETEN.

Step 13: Make site adjustments if requested and add to values of 1 and 10 hour fuel moistures.

Step 14: If no NFDRS indices are requested go to Step 19.

Step 15: Compute 100 and 1000 hour fuel moistures by use of routines M100 or M100A, depending on value returned from OPTFIX.

Step 16: Call subroutine CURING to determine state of green vegetation.
Step 17: Call subroutine ERCSC to determine the days NFDRS indices.
Step 18: Assign computed values of ERC and BI to elements 21 and 22 of IOB, respectively.
Step 19: Assign correct values of 1 and 10 hour fuel moisture to elements 19 and 20 of IOB, respectively.
Step 20: If computaions are to be saved for next run use, write them to the disk file that is called 'tape 2'.
Step 21: Call subroutine SUM. This routines does the intermediate statistical summaries.
Step 22: Read a new record (step 4).

At this point all records for the station have been read and summed in subroutine SUM and are ready for final computations and output.

Step 30: If no summary tables have been requested, skip to co-occurrence table output section. Otherwise, procede.
Step 31: Begin DO LOOP for each summary table requested (1 to NMEANS)
Step 32: Get summary parameter type, order, and write out header by call to RITE1. If fuel model was used, write out fuel model letter and slope class. Then write out table-tops.
Step 33: Begin DO LOOP for each month of data (1 to NMONTH).
Step 34: Begin DO LOOP for each period of the month (1 to 3).
Step 35: Set cumulative frequencies, relative frequencies, extreme values, and if cumulative frequency has reached 50% get median value (MED) by calling subroutine MIDPT2 (this is for first class interval).
Step 36: Begin DO LOOP for each class interval beginning at 2. (Number 1 was set in step 35).
Step 37: Set cumulative frequencies etc, as in 35 till median value is determined. Then end step 36 LOOP.
Step 38: Compute period mean, standard deviation, and output period mean, standard deviation, median, range values, and relative frequency distribution by calling RITE1.
Step 39: Continue LOOP from step 34.
Step 40: Continue LOOP from step 33.
Step 41: Repeat process, this time by monthly stratifications by summing three periods for each month, and outputing by call to RITE1.
Step 42: Repeat entire process for each summary table requested (Step 31).

At this point all summary tables have been computed and written to the print queue. Flow continues in computation and output of co-occurrence tables.

Step 50: If no co-occurrence tables were requested, Return to RXWTHR.
Step 51: Begin DO LOOP for number of co-occurrence tables requested.
Step 52: Set control points based upon options and order of options.
Step 53: If this table is a 2-way table, skip to step 70. Otherwise, procede.
Step 54: Begin DO LOOP for number of months.
Step 55: Sum total number of days in all periods of the month, and write out header and fuel model and slope class if needed.
Step 56: Zero out row and column totals and begin computation loops.
Step 57: First write out table-tops by calling subroutine RITE2.

Step 58: Begin DO LOOP for number of rows (class intervals) for first parameter in the table (1 to L4(Option(I,1)).

Step 59: Compute an entire row of percent frequency of co-occurrence for the class values and output the entire row by calling RITE2.

Step 60: Continue step 58 LOOP.

Step 61: Write out column frequency totals by calling RITE2 (there are two sets).

Step 62: Compute total frequency (row and colmn totals should be 100%) and write totals out along with the total count for the month (number of days in the sample).

Step 63: Repeat for each month in data set (step 54).

Step 64: Repeat for each table (step 51).

The next block is for computation and output of 2-way tables of co-occurrence.

Step 70: Begin DO LOOP for number of months

Step 71: Write headers and fuel model and slope class if needed.

Step 72: Zero out row and column arrays (ROWTOT and COLTOT)

Step 73: Write out table-tops.

Step 74: Compute simple 2-way co-occurrence frequencies and output results one row at a time.

Step 75: Compute row and column total, sample size and write it out.

Step 76: Repeat for each month (step 70).

Step 77: Repeat for each table (step 51).

At this point all summary and co-occurrence tables have been computed and queued to the printer.

Step 80: If computations were saved on disk, put end of file mark (eof) at the end of the data.

Step 81: Return to RXWTHR

SUBROUTINE CURING(INIT)

Narrative: Subroutine CURING is designed to model the progression of green vegetation through the growing season from dead, through green-up, through transition, and again to the dead or cured state. The subroutine was developed by the NFDRS work unit, and taken in entirerty from the NFDRS. Full Documentation of this subroutine is available through appropriate NFDRS publications.

COMMON BLOCKS USED: /OBSERVE/ , /FIRE/

FUNCTION DECL(MONTH,IDAY)

Narrative: This function computes the solar declination angle and is taken from NFDRS research. It is used for calculations of 100 hour fuel moisture.

FUNCTION DLIGHT(LAT,DECL)

Narrative: This function computes the total hours of daylite for the station latitude and the solar declination angle as computed in DECL. It is also used in calculations of 100 hour fuel moisture. DLIGHT was derived from NFDRS algorithms.

SUBROUTINE DUFF(INIT,DECL)

Narrative: This subroutine controls the calculation of duff moisture. It is still in the developmental stages and should be used with caution. "The model was developed from numerical and analytical solutions of the diffusion forms of the mass continuity equation and the first law of thermodynamics. Analytical solutions provided a fundamental framework to evaluate nonlinear interactions obtained in the numerical solutions. Dimensional analysis was used to define the relationship between the soil properties used in the model." 1/

COMMON BLOCKS USED: /OBSERV/ , /BLOCK1/ , /BLOCK2/

1/ Fosberg, Michael A, 1975, Heat and Water Vapor Flux in Conifer Forest Litter and Duff: A Theoretical Model, Abstract.

The logic is:

Step 1: Set subroutine constants.

Step 2: If it is the first time the subroutine has been called on this run, set up physical characteristics of the duff hoizon. These factors include (by layer):

1. Packing ratio (BETA)
2. Porostiy (PHI)
3. Vapor Diffusivity (NU)
4. Thermal Diffusivity (KAPPA)
5. Layer Moisture Timelag (TAURHO)
6. Layer Temperature Timelage (TAUTMP)
7. Modified Exponential Exchange Functions(temperature (CHITMP))
8. Modified Exponential Exchange Functions(vapor(CHIRHO))
9. Depth of layer (DEPTH)

Step 3: If it is initial season, call PROFL1 to set up initial temperature and relative humidity profiles of the horizons.

Step 4: Begin simulation

Step 5: Get input values of temperature and relative humidity

Step 6: Begin 24 hour duff moisture simulation (2 hour increments)

Step 7: Use harmonic analysis to model temperature and relative humidity cycles for each time increment.

Step 8: If TPTAMT is greater than zero, and simulation time is less than precipitation duration, it is still raining. GO TO step 10.

Step 9: This means that it has either stopped raining or did not rain. If EMC is less than FIBSAT regular solution will be used and SWITCH is .TRUE. for the layer. Otherwise, moisture is lost at the above saturation point rate as defined by DTHETA. This is done for each layer, and skips to step 11.

Step 10: Call PERCOL. This sets a perculation rate of free water through the horizons which is adsorpted to an extent by a value of DTHETA, and contributes to the overall moisture content of the horizon by a volumetric amount that is determined by solution of a 3rd degree polynomial equation by subroutine ROOT. This value is determined for each layer, and what is adsorped by one layer is not available for adsorption by the next.

Step 11: Determine vapor pressure for each layer and set top layer boundary conditions and intermediate layers to last value of layer above.

Step 12: Modify layer temp and density by exchange functions.

Step 13: Recalculatevapor pressure using new layer temperture (sat v.p.).

Step 14: Compute current saturation density.

Step 15: If EMC greater than FIBSAT, current density = saturation density.

Step 16: Compute vapor pressure and layer relative humidity from equation of state.

Step 17: If Switch of layer is TRUE get particle moisture by calling DUFFMC which calculates EQMC of particles based on temperature and relative humidity. Compute average, simulate next time period, until 24 hours have been simulated, then return to CMPUTE with IOB(8) = duff moisture.

SUBROUTINE DUFFMC(TEMP,HUMID,EQM,TYPE)

Narrative: Subroutine DUFFMC computes duff particle equilibrium moisture contents based on regression of the Wood Products Handbook, using predictors of temperature and relative humidity. It also computes EQMC's for soil or loam boundary layers.

FUNCTION EQMC(temp,rh)

Narrative: This function provides the same information as DUFFMC but is in the form of a function as does not have the capability for soil and boundary layer computations.

SUBROUTINE ERCSC(ERC,BI)

Narrative: This computational routine that determines potential fire behavior from the NFDRS fuel model and the current fire weather. It then computes the fire danger indices based on the potential fire behavior. The model is based on work of Rothermel (1972) and Abini(1976) and modified by Deeming in 1976. This routine is taken directly from the NFDRS system, and again is fully documented there.

COMMON BLOCKS USED: /FIRE/

SUBROUTINE ERROR(I)

Narrative: This subroutine is called by several routines in the system and is passed the value I. The routine is called when an error is detected. An error message is printed by means of a computed GO TO statement and processing continues or the program is aborted, depending on the severity of the error.

FUNCTION FREEZE(MINTEMP,NUMDAY)

Narrative: This function determines if a killing frost has occurred and is called by CURING. A killing frost is considered to have occurred if the min temp has been less that 33 degrees for a a total of 5 days, or if a minimum teperature of 25 degrees or less occurs. This logical function is taken from the NFDRS.

SUBROUTINE FUEL(II)

Narrative: This routine sets the parameters of the fuel bed for analysis or modeling by ERCSC. The routine contains the 20 NFDRS stylized fuel models, and assigns the correct values to the variables in COMMON BLOCK /FIRE/. FUEL is called by CMPUTE.

SUBROUTINE INTERP(MVALUE,MOPTIN)

Narrative: This routine interpret what was read in SETUP, sets program directives, and computation levels (L). It is passed the alphanumeric words that were read by SETUP, matches them with its own word dictionary, and sets option parameters and computation levels. If no match is found, ERROR is called with the appropriate value passed.

COMMON BLOCKS USED: /SET/ . /OPSET/

FUNCTION IOUT(KSET)

Narrative: This function examines the option number and sets a value (IOUT) for use in COMPUTED GO TO in the output routines.

FUNCTION IRND(X)

Narrative: This integer function rounds a real number then performs a FORTRAN standard IFIX operation on it.

INTEGER FUNCTION ISUB1(I,J,K,L)

Narrative: This function converts a four-way stratification into a vector for computer storage on a computer that is restricted to three dimensional arrays. This particular function is used in computing median values in the summary array MEDIAN.

INTEGER FUNCTION ISUB2(I,,J,K,L,M)

Narrative: This function converts a five-way stratification into a vector for computer storage. This particluar function is used in co-occurrrence stratification of array CUMCO.

INTEGER FUNCTION JET(I)

Narrative: This function categorizes precipitation and ERC values into graduated amounts that are more meaningful than the straight breakdowns of temperature or relative humidity.

SUBROUTINE M100(DECL,LAT,BNDRY)

NARRATIVE: This routine is called by CMPUTE to calculate 100 hour fuel moistures. It is the preferred method of 100 hour calculations. Maximum and minimum temperatures and relative humidities are used to calculate extreme values of equilibrium moisture contents which are then integrated with DLIGHT resulting in a weighted average value that is used in the 100 hour fuel moisture computations. This routine was developed by the NFDRS work unit and includes BNDRY values.

COMMON BLOCKS USED: /OBSERV/

SUBROUTINE M100A(IWTFLG,LAT,DECL,BNDRY)

Narrative: This routine developed by the NFDRS work unit is for computing fuel moistures (100 hour) when maximum and minimum values of temperature and relative humidity are not available. It uses default values of moisture recovery at night based on climate classes and yesterdays 100 hour moisture content in the computations of the fuel moisture. It then computes a boundary condition that is used in computations of 1000 hour fuel moistures.

COMMOM BLOCKS USED: /OBSERV/

SUBROUTINE M1000(BNDRY,MC1000,INIT)

Narrative: This NFDRS routine computes 1000 hour fuel moistures. It uses 7 day average boundary (BNDRY) condition as a driver function in the calculations. The boundary conditions are computed in either M100 or M100A.

SUBROUTINE MIDPT2(M,C,X,CO,J,L,L1)

Narrative: This routine computes the median value of an order ranked distribution by methods for large sample sizes described in SPSS[2]. M is the median value, C is the cumulative frequency, X is the last relative frequency, CO is the total

2/ SPSS, Statistical Package for the Social Sciences. 1975. Pg. 183.

sample size, J is an on/off switch, and L and L1 are the upper and lower class limits.

SUBROUTINE MODE(RF,J,ISET)

Narrative: This subroutine selects the modal class value from a relative frequency distribution. RF is the distribution, J is an on/off switch, and ISET is an option delimiter set in FUNCTION IOUT.

INTEGER FUNCTION NDEX(I,J,K,L,M)

Narrative: This function computes the vector element of a 5-way stratification adjustment vector. The stratifications are (1) aspect, (2) elevation, (3) slope, (4) cover, and (5) month.

SUBROUTINE ONETEN

Narrative: This subroutine computes 1 and 10 hour fuel moisture values from the daily fire weather observation. This routine was developed by the NFDRS, and has 1 added data check in it for use in this program.

The logic is:

Step 1: Set temperature and relative adjustment factors to get fuel bed temperatures and relative humidity, based on the cloud cover.
Step 2: Calculate equilibrium moisture content by FUNCTION EQMC.
Step 3: If stick moisture is reported and in reasonable limits, use it and calculate 1 hour fuel moisture from 10 hour. Return.
Step 4: Use regression constants to compute 1 and 10 hour fuel moisture.
Step 5: Return.

COMMON BLOCKS USED: /OBSERV/

SUBROUTINE OPTFIX

Narrative: This NFDRS routine computed which processing option will be used for fuel moisture computation. IOPTIN = 1 is the preferred processing option, and IOPTIN = 3 is the least desirable (or least information) option.

COMMON BLOCK USED: /OBSERV/

SUBROUTINE PERCOL

Narrative: This subroutine is called by DUFF in the case of precipitation to compute the percolation rate of free water through the duff horizons.

COMMON BLOCKS USED: /OBSERV/ , /BLOCK2/

The logic is:

Step 1: Compute precipitation rate.
Step 2: Set percolation rate as the minimum value of the precipitation rate of the hydraulic conductivity of the layer.
Step 3: Call ADSORP to compute THETA and DTHETA for the first layer.
Step 4: Adjust EMC and DMC as affected by THETA and DELTAM set SWITCH to .FALSE.
Step 5: Repeat for lower layers.
Step 6: Return to DUFF.

SUBROUTINE RELHUM

Narrative: This adaptation of an NFDRS routine computes the relative humidity given wet and dry bulb temperatures.

SUBROUTINE RITE1

Narrative: This is the main output subroutine for summary tables. It first calls ALPHA to change all output to an "A" format and then goes to the correct writing sequence via a series of computed GO TO statements operating on variables passed in the calling routine CMPUTE.

COMMON BLOCKS USED: /LABELS/ , /SET/ , /LIM/

SUBROUTINE RITE2

Narrative: This is the main output subroutinefor co-occurrence tables. It first calls ALPHA to convert REAL values to an 'alpha' format. It then goes to the proper entry point via computed GO TO statements operating on variables passed in the calling routine CMPUTE.

COMMON BLOCKS USED: /LABELS/ , /LIM/

SUBROUTINE ROOT(NC,III,JJJ,PPP,QQQ,RRR,ADFM)

Narrative: This subroutine solves an Nth degree polynomial by numerical methods. I don't know how it works and will not attempt an explanation. It was given to the project by Mike Fosberg.

SUBROUTINE SETUP

Narrative: This routine reads all user input information and 'sets up' the run. It is called by RXWTHR, calls INTERP and returns to RXWTHR. By reading and interpretation of control cards the program executes the proper read sequences by means of computed GO TO statements.

COMMON BLOCKS USED: /OPSET/ , /SET/ , /OBSERV/

The logic is:

Step 1: Read control card
Step 2: Interpret control card. If it is a RUN card go to step 3. Otherwise go to proper read sequence and return to step 1.
Step 3: Call INTERP
Step 4: Compute adjustment indices if required.
Step 5: Return to RXWTHR.

SUBROUTINE SUM

Narrative: This routine is the intermediate computational routine for statistical tables. It accumulates values for mean computations, sums of squares for standard deviation computations, extreme values for range computations, and class occurrence range values for relative frequency and co-occurrence computations. It also keeps track of sample size.

COMMON BLOCKS USED: /SET/ , /STATS/ , / OBSERV/ , /OPSET/

The logic is:

Step 1: Compute month index and period number, and add 1 to statified sample size.
Step 2: Begin DO LOOP for each summary table.
Step 3: Set index value (k)
Step 4: Accumulate mean values, and sums of squares.
Step 5: Get class interval of value.
Step 6: Add 1 to MEDIAN vector of frequency of occurrence by class level.
Step 7: Set high and low value for range analysis.
Step 8: Continue summary DO LOOP.

At this point all summary statistics have been processed. Now continue with co-occurrence summaries.

Step 9: Begin DO LOOP for number of co-occurrence tables.
Step 10: Set class interval for each of the two or three variables in the current table.
Step 11: Add 1 to the vector element of the current co-occurrence condition.
Step 12: Continue co-occurrence DO LOOP

At this point all intermediate summaries are finished.

Step 13: Return to CMPUTE.

SUBROUTINE TESTWX

Narrative: This NFDRS routine test each day's weather data for blatant errors, computes relative humidity if needed, and checks for precipitation duration. It sets missing precipitation duration values by default climate class values and sets some potentially undefined values of the IOB array.

COMMON BLOCKS USED: /OBSERV/

FUNCTION U20FNC(SGBRT,U20,WNDFC)

Narrative: This function reduces the 20 foot observed wind to a wind at midflame height, fuel type (depth) dependent.

SUBROUTINE VAPOR(T,EWS)

Narrative: This subroutine computes the saturation vapor pressure given the temperature in degrees K from the Smithsonian table. The routine is from the NFDRS and the pressure is returned in millibars.

RXBURN DOCUMENTATION

PART 3

GENERAL OVERVIEW OF RXBURN

Program RXBURN computes local presciption condition frequencies based on user-defined prescription conditions. All user input (except for the number of stations to be analyzed) is read in SETUP from device 5. All weather data is read from device 7 in subroutine CMPUTE. All output (except for error messages) is done from subroutine MEAN. RXBURN allows up to 15 prescription factors to be entered into a prescription.

The general flow of the program is as follows:

Step 1: Read number of station to be analyzed in mainline control program RXBURN.

Step 2: RXBURN calls SETUP which reads user control sequence. SETUP then calls subroutine INTERP to interpret user input, set program control variables and computation levels. INTERP then returns to SETUP which then computes adjustment codes if needed and returns to RXBURN.

Step 3: RXBURN then calls CMPUTE. CMPUTE sets initial values and begins reading weather data and computing needed values as per user sepecification.

Step 4: CMPUTE then calls SUMMER which tests to see if the prescription factors just read/computed consitute a preferable condition, an acceptable condition, or an unacceptable condition. SUMMER then accumulates values needed for mean values, run lengths, and persistence probabilities. SUMMER then returns to CMPUTE which reads the next days weather.

Step 5: When all weather data has been read, analyzed, and summed, CMPUTE calls MEAN. Subroutine MEAN computes all final statistics and writes all output to the printer queue. MEAN then returns to CMPUTE.

Step 6: CMPUTE returns to RXBURN to check for another station to analyze. If there are none, the program terminates normally. If there is, general flow returns to step 2. This is repeated until all stations have been analyzed.

In the following pages, the COMMON BLOCKS used by RXBURN are first defined. Mainline program RXBURN is then documented, followed by all other subroutines and functions in alphabetical order.

PROGRAM RXBURN

Narrative: Program RXBURN is the mainline control program for the assessment of local prescription condition frequencies. It keeps track of the number of stations to be analyzed and the number that have been analyzed.

The logic is:

Step 1: Set run number to zero.
Step 2: Read number of stations to be analyzed.
Step 3: If at eof, terminate the run normally. If not continue to step 4.
Step 4: Call SETUP
Step 5: Call CMPUTE
Step 6: Rewind disk file created by SAVE option (if used) and add 1 to the run number.
Step 7: Check to see if last station has been analyzed. If not, return to step 2. If so, rewind weather data file, set run number to zero and return to step 2.

SUBROUTINE ADSORP

Narrative: Same as RXWTHR.

FUNCTION CALV

Narrative: Same as RXWTHR

SUBROUTINE CMPUTE

Narrative: This routine is a major weather reader and computational block. It performs the exact processes that make up the balance of CMPUTE in RXWTHR except that no statistics are computed. In RXBURN, the statistics and output are handled in subroutines SUMMER and MEAN.

COMMON BLOCKS USED: /SET/ , /OBSERV/ , /FIRE/

The logic is:

Steps 1 through Step 22 are essentially the same as RXWTHR except for two items. First, alpha input LIMIT values are DECODED to integer format, and secondly, SUMMER is called instead of SUM at step 21.

Step 30: Call SUMMER to close out last observation strings, and ENCODE LIMIT back to alpha formats for output.
Step 31: Call MEAN and put eof on tape 2 (disk file).
Step 32: Return to RXBURN

PART 4

COMMON BLOCKS:

Program RXBURN uses 7 labeled COMMON BLOCKS and no unlabeled COMMON BLOCKS. All values are set in the programs and none in DATA statements. The COMMON BLOCKS are defined as follows.

COMMON /BLOCK1/	:	This common block is the same as /BLOCK1/ of RXWTHR.
COMMON /BLOCK2/	:	This common block is the same as /BLOCK2/ of RXWTHR.
COMMON /FIRE/	:	This common block is the same as /FIRE/ of RXWTHR.
COMMON /OBSERV/	:	This common block is the same as /OBSERV/ of RXWTHR.
COMMON /SET/	:	Values needed for the setting up and control of Program RXBURN are held in this common block. It is basically a combination of values from /OPSET/ and /SET/ of RXWTHR, plus variables needed in RXBURN.
VALUES SET	:	Most values in this block are set in subroutine SETUP and subroutine INTERP.
ARRAYS	:	DESCRIPTION
ACT(16)	:	containsalphanumeric activity information (16A5 elements)
DIST(3)	:	contains alphanumeric district information (3A5 elements)
FOREST(3)	:	contains alphanumeric forest information (3A5 elements)
IRXOP(15)	:	contains pointer values for picking right IOB element in prescription analysis.
LAMAT(15,2,2)	:	contains alphanumeric prescription limits stratified by prescription parameter, preferable prescription (RX) minimum limit, preferable RX maximum limit, acceptable RX minimum limit, and acceptable RX maximum limit.
LIMIT(15,2,2)	:	contains integer limits for prescription, stratified the same as in LAMAT.
NAME(3)	:	contains alphanumeric user name (3A5 elements)
NAMSTA(3)	:	contains alphanumeric station name (3A5 elements)
NRXOP(15)	:	contains the order of values in IRXOP.
VARIABLES	:	DESCRIPTION
ADJUST	:	Logical indicator whether adjustment option is on or off.
ELEV	:	Elevation of base fire weather station in feet.
IASP	:	Aspect adjustment code for use when ADJUST is true.
ICOV	:	Canopy cover adjustment code for use when ADJUST is true.
IDAYB	:	Day of year to begin inclusion of days in sample.
IDAYE	:	Day of year to end inclusion of days in sample.
IDUFF	:	On/off switch that indicate if duff moisture is to be calculated.

IELV	:	Elevation band adjustment code used when ADJUST is true.
ISLO	:	Slope adjustment code used when ADJUST is true (is computed automatically from slope class entry (ISLOPE)).
IYEARB	:	Year to begin inclusion of data in sample.
IYEARE	:	Year to end inclusion of data in sample.
L	:	Indicates computation level of program.
LAT	:	Station latitiude.
MOD	:	NFDRS fuel model to be used in NFDRS index calculations.
MONTHB	:	Month to begin inclusion of data in sample.
MONTHE	:	Month to end inclusion of data in sample.
NUMSTA	:	Six digit station identifier code.
NYEARS	:	actual number of years data availability.
REPEAT	:	Logical variable that identifies if run is a repeat run which means that disk file created by a save run is used.
SAVE	:	Logical variable that identifies if run is a save run which means that disk file is created.
SITELV	:	Elevation of burning site. Used in computing IELV.

COMMON /STATS/ : This common block contains most of the arrays needed for computation of prescription condition frequencies.

VALUES SET : Most values are set in SUMMER, a few are set in MEAN. Values are zeroed out in ZERO1.

ARRAYS	:	DESCRIPTION
KOUNT(12,3)	:	Holds sample size, stratified by month, and 10-day period of the month.
KTRAN(12,3)	:	Holds the number of prescription tranisition from one type to another (or persistence of one type). Stratified by month, and prescription type (1 = preferable, 2 = acceptable, 3 = unacceptable).
LACC(12,3)	:	Accumulating array for mean run length of acceptable prescriptions stratified by month and 10-day period of month.
LPER(12,3)	:	Accumulating array for mean run length of preferable prescriptions.
LUNA(12,3)	:	Accumulating array for mean run length of unacceptable prescriptions.
LRNACC(12,3,11)	:	Accumulating array for quartile analysis of acceptable prescriptions stratified by month, period of month, and run length. The value of LRNACC(5,2,4) for example would be the number of 4-day acceptable prescription run lengths in the 2nd period of the 5th month in the analysis. This array is for run lengths stratified by periods (i.e. the maximum run length in a monthly period is 11 days.)
LRNPER(12,3,11)	:	Accumulating array for quartile anaysis of preferable prescriptions. It is stratified the same as LRNACC.
LRNUNA(12,3,11)	:	Accumulating array for quartile anaysis of unacceptable prescriptions. It is stratified the same as LRNACC.

MLACCM(12)	:	Accumulating array for mean run length of acceptable prescription, stratified by month.
MLPERM(12)	:	Accumulating array for mean run length of preferable prescription, stratified by month.
MLUNAM(12)	:	Accumulating array for mean run length of unacceptable prescription, stratified by month.
MRLACC(12,31)	:	Accumulating array for quartile analysis of acceptable prescription, stratified by month, and length of prescription. The value of MRLACC(5,13) for example would be the number of times that a 13-day acceptable run length occurred in the fifth month of analysis. The value at MRLACC(5,31) would be the number of times every day of the month (if 31 days in the month) was an acceptable prescription condition.
MRLPER(12,31)	:	Accumulating array for quartile analysis of preferable prescription. It is stratified the same as MRLACC.
MRLUNA(12,31)	:	Accumulating array for quartile analysis of unaccetable prescription. It is stratified the same as MRLACC.
NUM(12,3,3)	:	Accumulating array that keeps track of prescription type transitions. Stratification is by month, initial prescription type, and prescription type after transition.
NUMACC(12,3)	:	Accumulating array for mean number of acceptable prescription days, stratified by month and 10-day period of the month.
NUMPER(12,3)	:	Accumulating array for mean number of preferable prescription days, stratified by month and 10-day period of the month.
NUMUNA(12,3)	:	Accumulating array for mean number of unacceptable prescription day, stratified by month and 10-day period of the month.

COMMON /STATS2/ : This common block contains prescription condition frequency values for monthly period. Values are set in MEAN and zeroed out before each run in ZERO2.

ARRAY	:	DESCRIPTION
KONTM(12)	:	Total sample size, (number of days) per month.
NACCM(12)	:	Total number of acceptable prescription days per month.
NPERM(12)	:	Total number of preferable prescription days per month.
NAF(12,3)	:	Frequency of acceptable prescription days, stratified by month and period of month.
NPF(12,3)	:	Frequency of preferable prescription days, stratified by month and period of month.
NUF(12,3)	:	Frequency of unacceptable prescription days, stratified by month and period of month.
NAFM(12)	:	Frequency of acceptable prescription days by month.
NPFM(12)	:	Frequency of preferable prescription days by month.
NUFM(12)	:	Frequency of unacceptable prescription days by month.

SUBROUTINE CURING

Narrative : Same as RXWTHR.

FUNCTION DECL

Narrative : Same as RXWTHR.

FUNCTION DLIGHT

Narrative : Same as RXWTHR.

SUBROUTINE DUFF

Narrative : Same as RXWTHR.

SUBROUTINE DUFFMC

Narrative : Same as RXWTHR.

FUNCTION EQMC

Narrative : Same as RXWTHR.

SUBROUTINE ERROR

Narrative : Same as RXWTHR.

FUNCTION FREEZE

Narrative : Same as RXWTHR.

SUBROUTINE FUEL

Narrative : Same a RXWTHR.

FUNCTION INDEX

Narrative : Same as FUNCTION NDEX in RXWTHR.

SUBROUTINE INTERP

Narrative : Same as RXWTHR with changes for RXBURN.

FUNCTION IRND

Narrative : Same as RXWTHR.

SUBROUTINE M100

Narrative : Same as RXWTHR.

SUBROUTINE M100A

Narrative : Same as RXWTHR.

SUBROUTINE M1000

Narrative : Same as RXWTHR.

SUBROUTINE MAX

Narrative : This subroutine selects the maximum occurrence frequency for summary output of highest month and 10-days of frequency of prescription occurrence.

SUBROUTINE MID

Narrative : This subroutine selects quartile values of run length as called by MEAN at the right time, and sets a switch that indicates value has been computed.

SUBROUTINE MEAN

Narrative : This subroutine makes the final calculations of accumulation arrays and does all program output.

COMMON BLOCKS USED: /SET/ , /OBSERV/ , /STATS/ , /STATS2/

The logic is:

Step 1: Set initial values and call ZERO2.
Step 2: Set total counts for seasonal, monthly and 10-day period values, and write out first page header and prescription entries.
Step 3: Compute average number of days of each prescription type per season and associated frequencies and output values.
Step 4: Select highest monthly frequency of each pescription type and write them out. Up to 2 highest months are allowed for cases of equal frequencies.
Step 5: Select 10-day period of highest prescription frequency of each type and output. Again, up to 2 are allowed.
Step 6: Write out monthly and 10-day summaries of seasonal progression

of prescription condition occurrence.

Step 7: Write out seasonal totals.

Step 8: Calculate and output mean values and quartile values of run length by monthly and 10-day periods.

Step 9: Compute and write persistence and transition probabilities using a simple markov model. Stratification is by month.

Step 10: Return to CMPUTE.

FUNCTION MTH

Narrative : This function sets a month pointer for use in output of the alpha month.

SUBROUTINE ONETEN

Narrative : Same as RXWTHR.

SUBROUTINE OPTFIX

Narrative : Same as RXWTHR.

SUBROUTINE PERCOL

Narrative : Same as RXWTHR.

SUBROUTINE RELUM

Narrative : Same as RXWTHR.

SUBROUTINE ROOT

Narrative : Same as RXWTHR.

SUBROUTINE SET

Narrative : Sets switch values for use in determination of maximum frequencies in MEAN.

SUBROUTINE SETUP

Narrative : Same as SETUP in RXWTHR with appropriate changes for RXBURN values.

SUBROUTINE SUMMER

Narrative : This routine fills the accumulating arrays contained in COMMON BLOCK /STATS/.

The logic is:

Step 1: Set initial values- month number, period number, and increment sample size counter.
Step 2: Check for beginning of season (INIT) and set appropriate value as needed.
Step 3: Determine if day is 'preferable' , 'acceptable' , or 'unacceptable.
Step 4: Increment mean value accumulator arrays.
Step 5: Increment appropiate run length counters.
Step 6: Determine if prescription 'type' string was broken. If not go to step 8.
Step 7 Set appropriate run length counter arrays depending on what 'type' of string was broken.
Step 8: Set counting arrays for use in Markov model.
Step 9: Set all todays values to holding value to becomes yesterdays value on the next day.
Step 10: Return to CMPUTE.

SUBROUTINE TESTWX

Narrative : Same as RXWTHR.

FUNCTION U2OFNC

Narrative : Same as RXWTHR.

SUBROUTINE VAPOR

Narrative : Same as RXWTHR.

SUBROUTINE ZERO1

Narrative : Sets all values in common block /STATS/ to zero for each run of RXBURN.

COMMON BLOCKS USED: /STATS/

SUBROUTINE ZERO2

Narrative : Sets all values in common block /STATS2/ to zero for each run of RXBURN.

COMMON BLOCKS USED: /STATS2/

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